The Engineer

LONDON, FRIDAY, JULY 3, 1942.

PUBLIC NOTICES

UNIVERSITY OF LIVERPOOL

FACULTY OF ENGINEERING

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FACULTY OF ENGINEERING

Dean: Professor R. G. BATSON, M.Eng., A.K.C., M. Inst. C.E., M.I. Mech. E.

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The Engineer

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NOTICE

CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:

28, ESSEX STREET, STRAND, LONDON, W.C.2, and NOT to Bath.

This change has been caused by enemy action, and co-operation is earnestly asked for.

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SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1941 No. 2069

RESTRICTION ON ENGAGEMENT ORDER

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

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The Engineer

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of THE ENGINEER.

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For continuation of Small Advertisements see page 60

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THE ENGINEER

A Seven-Day Journal

Engineers in the Army

IN the House of Commons on Tuesday, June 30th, Mr. A. Woodburn asked Sir James Grigg, the Secretary of State for War, whether he had considered the leading article on "Engineers in the Army" in THE ENGINEER of June 12th, a copy of which had been sent to him, in which it was asserted that Army officers with mechanical engineering training could not attain such high rank in the Army as was possible in the Navy; and whether, in view of the importance of mechanical engineering in modern warfare, he would cause such a readjustment as to permit of such promotion for engineer officers as would bring their advice and ability on to levels commensurate with the importance of mechanical warfare. Mr. W. F. Higgs also asked the Secretary of State for War whether he was aware that officers in the Army who remained constant to engineering had no chance of rising to a higher rank than major-general, and, in view of the increase in mechanisation, would he investigate the possibilities of removing that restriction. In his reply to these two questions, Sir James Grigg said that the importance of mechanical engineering in modern warfare was fully recognised, and the desirability of providing suitable promotion prospects for officers with mechanical engineering knowledge would not be lost sight of. Mr. Higgs asked further whether Sir James was aware that the engineer in the Navy could obtain the rank of vice-admiral, and whether he would give further consideration to the question of granting equal rank in the Army to the engineer, that was lieutenant-general. Sir James replied that he would consider it, but pointed out that rank was not merely given as a personal tribute, but in accordance with the responsibilities of the post. Mr. Woodburn, in a further question, raised the matter of the desirability of having on the highest councils of the war direction an officer with mechanical engineering knowledge, and asserted that this omission had in the past contributed greatly to the lack of suitable *liaison*. Sir James said that he did not think that was the case, as there was abundant *liaison* in technical affairs between the Ministry of Supply and the War Office.

The "Bristol" Flying Boat

IT has now been made known that the Prime Minister made his recent voyage to the United States, also the return journey, in the Royal Mail aircraft "Bristol," of British Overseas Airways. The commander was Captain J. C. Kelly Rogers, who was in command of the "Berwick" when it brought back the Prime Minister from his previous visit to America, and the second in command was Captain A. C. Loraine, who was second in command of the "Berwick." The "Bristol" is a Boeing 314 A flying boat, and is one of three such aircraft which operate the British Airways' Atlantic services to the United States and also, in conjunction with other flying boats, to West Africa. These Boeings, it is claimed, are among the largest flying boats in commercial service in the world. The wing span of these machines is more than 150ft., with a length of 105ft., and a height of more than 27ft. When fully loaded they weigh almost 40 tons, and the four engines have a total output of 6400 B.H.P. These aircraft are designed to carry up to sixty-six passengers, according to the length of the voyage, and the crew is ten in number. They have a cruising range of over 4000 miles. At present they are carrying over thirty passengers on their Atlantic voyages. The passengers are carried in a number of commodious cabins, which can be converted into sleeping berths at night. There is a private suite aft, and other accommodation includes a purser's office, a cooking galley, and a pantry. Dining accommodation is provided for fourteen passengers at one time. The crew of each flying boat comprises the captain, second captain, first officer (who acts as navigator), two engineer officers, the purser, and two stewards.

The Control of Canals

IT was officially announced by the Ministry of War Transport last week that the principal canals and public carriers in Great Britain are to be controlled in the same manner as the British railways. The Ministry's decision will take effect as soon as the financial arrangements have been agreed upon. The object of this new decision, it is explained, is to relieve as far as possible the existing road and rail traffic. It is expected that about 2000 miles of canals will come under the scheme. The canals, it is stated, will continue to be run by the existing organisations; control, however, will be exercised over the charges to be made for water transport. By treating the entire canal system of the country as a single unit, instead of a number of separate concerns, considerable economies may be expected. Thus barges may be diverted to canals where there may be an urgent demand for them. The principal canal systems which will come under the new control scheme are those of the Aire and Calder Navigation Company, the Birmingham Canal Navigation Company, the Grand Union Canal Company, the Leeds and Liverpool Canal Company, the Trent Navigation Company, the Manchester Ship Canal Company, and the Bridgewater Canals, and the Lee Navigation. It may be recalled that the total trade carried by the canals in this country in the last pre-war year was approximately 17,000,000 tons. Under the new scheme this is likely to be increased.

Railway Wages

AT the annual conference of the National Council of Locomotive Operators, a section of the National Union of Railwaymen, which took place at Rhyl on Monday last, June 29th, it was announced that the N.U.R. had submitted to the railway companies an application for a wages increase of 10s. a week for all grades of railway workers. The claim is being investigated by the companies. After the conference, the Secretary of the Council, Mr. H. Simpson, of Burnley, said that railwaymen were determined to obtain this moderate advance. They were, he added, dissatisfied with the awards recently made, which, it was claimed, improved the position of the lower grades of workers only, and gave them a minimum wage of £3 3s. If the negotiations were unsuccessful, then the union contemplated serious action, which, he said, might include strike action. The conference was attended by 120 delegates, representing 400,000 members. In the course of his speech, Mr. W. Ballantine, of Perth (the President), pointed out that in 1941 the railway companies made a profit of £65,000,000, which exceeded the sum of £43,000,000 by £22,000,000. Out of that sum the railway companies proposed to allocate the sum of £2,000,000 for wage increases. The National Executive of the N.U.R. had, he said, rightly rejected that proposal. It contended that the major portion of the £22,000,000 should find its way into the pockets of the men and women who were running the railways to-day. Supporting the new application for a further increase, Mr. Ballantine said that they should also be beginning to demand a share in the control of the industry. On the question of the introduction of women workers into the railway system, the President expressed satisfaction that the N.U.R. were accepting them as members.

John Brown and Co., Ltd.

IN dealing with the shipbuilding activities of the company at the general meeting of John Brown and Co., Ltd., which took place in London on Friday, June 26th, Lord Aberconway, the chairman of the company, said that although he could not give any details of the work being done at Clydebank, it appeared from a general survey of shipbuilding that manpower was now the measure of output. In the firm's Clydebank yard, with the co-operation of the unions concerned, the more highly skilled workers of the more vital trades had been diluted to the maximum degree of effectiveness by the upgrading of less skilled workers in these trades and by the transfer of men from other trades. The effect on the national output of such action, if not generally adopted in shipyards, was, however, relatively small, and until such dilution was, in fact, adopted universally throughout the shipbuilding industry any marked increase in the present output of naval and merchant tonnage could not be expected. At Clydebank and at the other establishments in which the company was interested, all of them doing work of the utmost importance, the company had had the assistance of a most skilled and hard-working staff. The board, Lord Aberconway said, felt every gratitude to its staff, and appreciated the value of what had been done by a very great number of able and industrious workpeople in the company's employ.

Conference on Mineral Resources

IT is announced by the British Association that a conference on mineral resources and the Atlantic Charter will take place on July 24th and 25th at the London School of Hygiene and Tropical Medicine. It will be opened by Sir Richard Gregory, F.R.S., President of the Association, and the chair at the successive sessions will be taken by Sir Thomas Holland, F.R.S., Sir William Larke, Dr. C. H. Desch, F.R.S., and Sir Stafford Cripps. Among expected speakers are Professor H. H. Read, F.R.S., Professor C. B. Fawcett, Professor W. R. Jones, Sir Lewis Fermor, F.R.S., Dr. E. F. Armstrong, F.R.S., Dr. W. H. Hatfield, F.R.S., Dr. L. Dudley Stamp, and Professor J. G. Smith. As the world's natural resources, both organic and inorganic, are much too large a subject to be dealt with in a single conference, coal and oil will not be discussed, except incidentally. A survey of the present position in relation to minerals of industrial importance, however, with suggestions for further investigations into their geographical distributions, and research into the production of substitutes, should, the Association states, reveal the close contact between science and fundamental national and international problems. By presenting the chief facts of natural resources of minerals and their geographical control, the conference will aim at helping to promote recognition of the interdependence of nations and the need for collaboration between them.

Railway Signalling for Wartime Traffic

No. I

BETWEEN the outbreak of war and the opening of the German offensive on the Western Front, it was generally anticipated that the railways of this country would have as their main war task the operation of traffic for the supply and reinforcement of a British Expeditionary Force fighting in France and the Low Countries. For such a traffic, with the experience of the last war in mind, they were prepared. But following the swift change in the strategic position in June, 1940, there evolved, gradually, a different task, one bound up with the maintenance of the Atlantic life-line. As a result, traffic began to flow along channels other than those of ordinary peacetime commerce; the need arose to work to their utmost capacity lines normally classed as byways, and to use roundabout routes, not merely as alternatives in case of air raid damage, but as a regular supplement to the normal arteries of traffic.

It was not only on hitherto placid cross-country lines that existing facilities were found, naturally, to be inadequate; on the less-used trunk routes there were localities in which loop line and siding accommodation was restricted, and under the pressure of this new and growing traffic numerous bottle-necks were revealed. In the alteration and improvement of track lay-outs, new signalling was required, and the accumulated experience of pre-war years has proved valuable in the solution of these wartime problems, all of which have had to be considered under three headings:—

(1) Speed of installation.
(2) Economy in material.
(3) Economy in operation, both in electric power, if used, and man power.

In preparing all the schemes about to be described the expeditious handling of heavy goods traffic was the main consideration—how this can be done with the minimum of interference to passenger, mail, and such fully braked freight trains as are run at express speed.

A characteristic feature of the lay-out of many British routes in the past was the studied avoidance of the use of facing points wherever possible. Perhaps the most extraordinary instance of this policy was to be found on a trunk line in the North of England where for over 70 miles there was not a single pair of facing points. In such conditions the side-tracking of a heavy goods or mineral train to make way for faster traffic is a slow job, involving a long draw ahead, followed by an equally slow shunt back into the refuge siding. Many of these sidings are now being converted into running loops, as shown in Fig. 1, and a considerable amount of time is saved in the stowage of heavy goods trains. The change in lay-out necessarily involves changes in the signalling, and these are indicated on the diagram in Fig. 1. To operate traffic to the best advantage, these loops should be as long as convenient, and the points at the entering end may be as much as 1000 yards from the signal-box at the station. Before the introduction of power signalling, a new signal-box would have been necessary at the entering end of the loop, but in the cases now under consideration the changes have been made with very little extra equipment.

The facing points A are electrically worked from the existing signal-box, power supply at 110 volts being provided by a hand generator. The splitting signals reading over the points A are worked by wire, and the distant signal B, which may be any distance up to 2000 yards from the signal-box, is electrically worked. All these new functions are controlled from full-sized levers in the existing mechanical locking frame, new levers being added if enough spares are not available. It will be appreciated that in the majority of instances the entering end of the loop will be out of sight of the signalman, and a scheme of track circuit indication has therefore to be provided for safe working. The splitting signals are approach-locked by track circuit C. Fig. 2 shows an actual installation of a hand generator in a mechanical signal-box.

In the operation of heavy goods trains the time saved is surprisingly great. In the example shown graphically in Fig. 3, a goods train weighing 700 tons behind the tender, and having a normal running speed of 25 m.p.h., is clear of the main line at least 8 min. sooner than if shunting back were necessary. Not only is this advantageous in clearing the line quickly for priority traffic of a faster category, it also enables the slow trains to make their journeys more expeditiously. In Fig. 4 is shown a time-distance chart for two goods trains, one travelling at 25 m.p.h. and the other at 50 m.p.h. To avoid delaying the fast train the slow one would have to be shunted at station B with the old type of lay-out, whereas with a carefully designed running loop lay-out it could be permitted to proceed as far as D. The time saved in the working of the 25 m.p.h. train in this particular example is 9 min., over this one incident only. The cumulative effect of a series of such installations can have a profound effect on traffic working.

On routes having only a single line of railway greater difficulties are experienced, and very careful attention must be given to the matter of loop accommodation at passing places. When many such railways were originally laid out, signal-boxes were provided at each end of the loops, as shown in Fig. 5. The subsequent decline in traffic and the need for the greatest possible economy in working expenses led to the closing of some of these boxes, leaving one to control the entire loop. While this can be readily accomplished by modern signalling methods, it not infrequently leads to considerable delay when two lengthy trains have to be crossed. Even if both are passenger or fully fitted freights, each train may be kept 5 min. to 7 min., while single-line tokens from each are inserted in the respective block instruments and fresh tokens issued to each driver. With loose-coupled goods trains the process is considerably longer, for the signalman must see that the tail lamp of each train is in position, thus ensuring that no breakaway has occurred in the section.

An analysis of train working over a single-tracked route usually shows that one or two sections are, on account of physical conditions, more prone to cause delays than the rest. In certain instances of this kind traffic operation has been greatly improved by the complete abolition of single-line token working, and the use instead of continuous track circuiting and a system of co-operative train despatching worked by the signalmen at each end of the section. Fig. 6 shows such a lay-out diagrammatically. The track circuiting eliminates the need for observation of tail lamps, as a breakaway would be detected at once. A train travelling from A to B and waiting in the loop at A can be despatched as soon as the train in the opposite direction arrives, since there is no necessity for the signalman to walk the length of the train to hand the single-line token to the driver. The train travelling from B to A can pass loop A without stopping. Under these improved conditions the train travelling from A to B will save at least 5 min. on this part of its journey. With the train travelling in the opposite direction there would be no change for a passenger train or a fully fitted freight, either of which could in any case pass without stopping if the train in the opposite direction had already arrived. If, however, the train from B to A was a loose-coupled goods, the avoidance of the stop for examination might save as much as 15 min. in running.

In providing these improved facilities certain safeguards have to be included in the signalling arrangements. The general scheme is best described by following through the movements to be made by the two signalmen before a train can be sent, for example, from A to B, the single-line section being assumed clear. The ordinary bell signals are exchanged; then B—the leaving end of the section for this particular train—pulls his "direction lever." This electrically locks the corresponding lever at A, so preventing

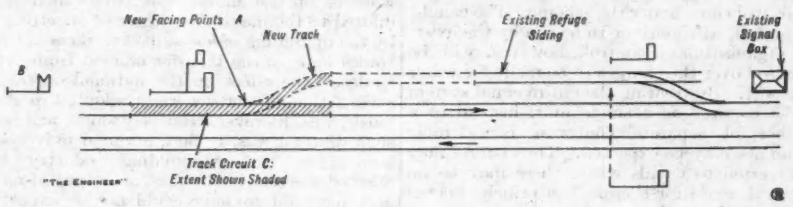


FIG. 1—CONVERSION OF SIDING TO RUNNING LOOP

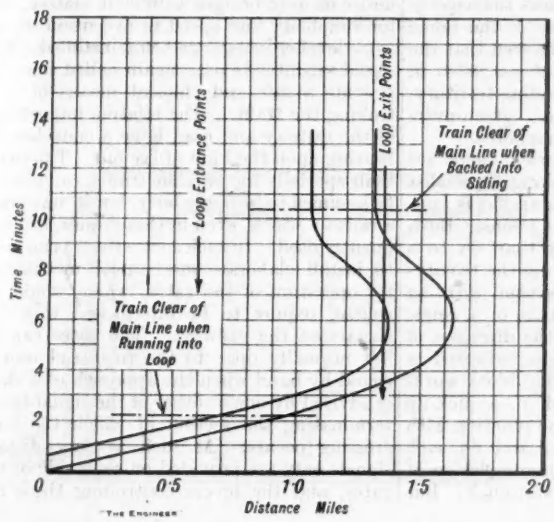
FIG. 2—HAND GENERATOR IN MECHANICAL SIGNAL BOX

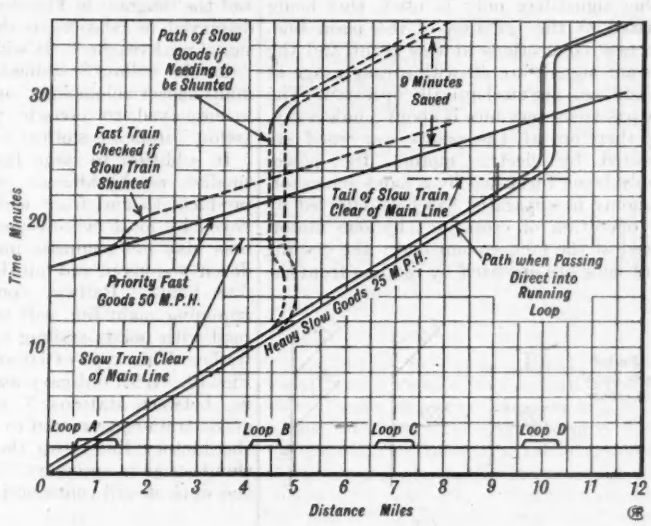
the latter signalman from inadvertently trying to initiate a move in the opposite direction. The pulling by B of the correct "direction lever" electrically releases the starting signal marked C on the diagram. Once pulled, the direction lever is so interlocked electrically that it cannot be restored to normal until the train has entered the section from loop A, travelled its entire length, and arrived in loop B. If, for any reason, it became necessary to hold up the despatch of the train after the "direction lever" had been pulled, this can be done by suitable co-operative action by the two signalmen.

War traffic has revealed bottle-necks in normally busy localities, as well as on cross-country routes having a newly assumed importance. An interesting case occurred where connection was made between a four-track main line of one railway and a double track cross-country route of another. Local conditions arising from war traffic rendered the existing connection inadequate, and duplicate roads, permitting of parallel transfer movements, were laid in. Fig. 7 shows in diagrammatic form the general lay-out of the tracks, and it will be realised that the additional work here was on a considerably larger scale than the construction of the running loops discussed earlier in this article. Furthermore, the new connections left the four-track main line at a distance of 500 yards from the existing junction signal-box. The circumstances might, indeed, have justified the building of a new signal-box. But, having in view economy in working expenses, through economy in man power, a scheme was evolved for controlling the new junction from the existing signal-box without enlarging the latter.

An all-electric locking frame, containing the necessary nine levers for points and eighteen levers for signals, was installed at one end of the existing signal-box. This frame is quite compact and takes up little space. The point to be emphasised, however, is that this power frame, although a separate unit, is, from the operating point of view, part of the existing mechanical locking frame. For safe working interlocking is needed between levers in the mechanical and power units, and this has been accomplished by electric locks coupled to the tails of the mechanical levers, electrically connected to the contacts on the power frame levers. This interesting solution has therefore (*a*) avoided the need of a new signal-box, and, since it would have been continuously open, saved three signalmen; (*b*) brought the new connecting lines under the same direct control as the old, with obvious operational advantages; and (*c*) by the latter, additional block working has been avoided.

New passenger stations, goods sidings, and additional connections have been laid out in many parts of the country to serve newly built factories. In some instances, a station already existed near the chosen site for the factory, while in others, situated in country districts, the passenger facilities already available were obviously inadequate for the large number of workers who would eventually travel to and from the factory every day.


Time Minutes
Loop Entrance Points
Loop Exit Points
Train Clear of Main Line when Backed into Siding
Train Clear of Main Line when Running into Loop
Distance Miles


Path of Slow Goods if Needing to be Shunted
9 Minutes Saved
Fast Train Checked if Slow Train Shunted
Tail of Slow Train Clear of Main Line
Path when Passing Direct into Running Loop
Priority Fast Goods 50 M.P.H.
Heavy Slow Goods 25 M.P.H.
Slow Train Clear of Main Line
Loop A
Loop B
Loop C
Loop D
Time Minutes
Distance Miles

FIGS. 3 AND 4—TIME-DISTANCE CHARTS SHOWING SAVINGS EFFECTED BY ADOPTION OF RUNNING LOOPS

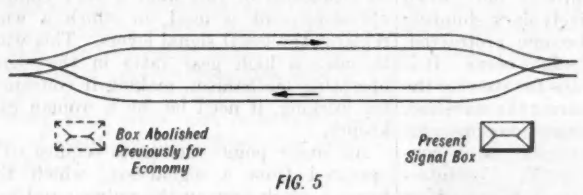


FIG. 5

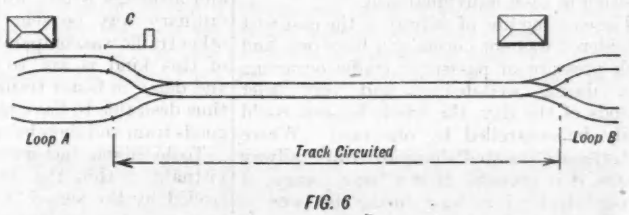


FIG. 6

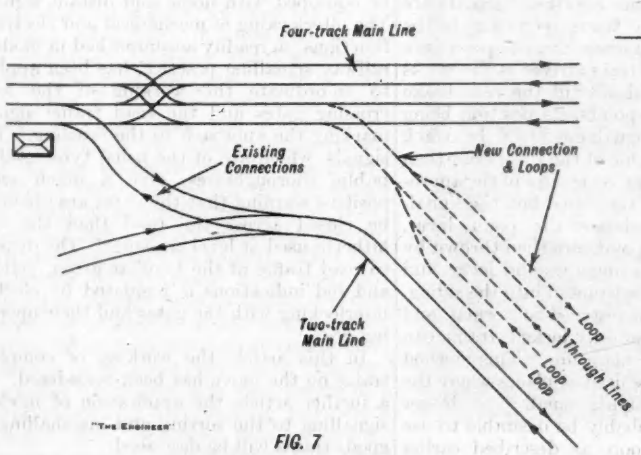


FIG. 7

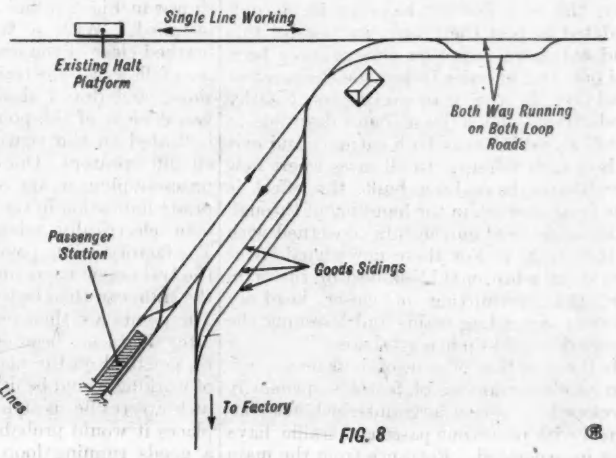


FIG. 8

FIGS. 5-8—DIAGRAMS ILLUSTRATING SOME IMPROVED LAY-OUTS

An interesting example of the latter was treated as shown in the schematic lay-out, Fig. 8. Here a new station was built specially for the factory workers, entirely clear of the existing line of railway, and at such a distance as to permit of shunting, marshalling, and storing the special rolling stock without fouling the main line and without interfering with goods traffic to and from the factory. The signalling of these new lines provides a good example of modern methods, wherein mechanical and electrical appliances are used together in a judicious blend.

One signal-box only is used, this being situated at the junction of the main line. The new connections at this point and the relevant signals are all within easy range of the box, and are mechanically operated. The new passenger terminus is about ½ mile away, and therefore all the points concerned are operated by electric motors, the power supply being furnished by a hand generator. Economy in apparatus has been effected by the operation of crossovers by one motor, placed at the facing point end; the trailing point ends are operated by rodding from the

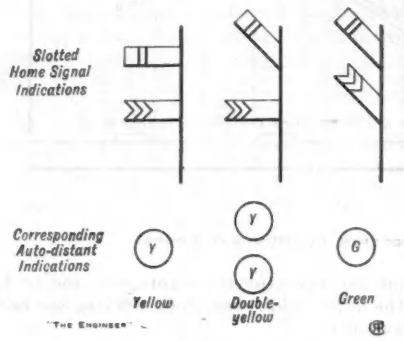


FIG. 9

respective motors. Track circuiting and an illuminated diagram in the signal-box are, of course, necessary for safe and efficient operation from this distance, though the semaphore signals are all wire worked. Electric contact-boxes are, however, actuated by link mechanisms connected to the semaphores, and indicate to the signalman the position of each individual arm.

The existing line of railway in the case just considered was not normally a busy one, and with pressure of passenger traffic occurring only during well-defined and very brief periods of the day, the whole lay-out could easily be controlled by one man. Where factories are situated alongside trunk railway routes, it is probable that a large volume of through traffic is passing during the twenty-four hours, and individual workings to and from the new factory have to be accommodated as best they can. In cases of this kind extensive reception sidings have been laid out, and in order to provide the greatest flexibility in the manœuvring of lengthy goods trains, it has been found desirable to install signal-boxes at both entrance and exit ends of such sidings. In all cases where new signal-boxes have been built, the effect is beneficial as much in the handling of through trains as in local movements concerned with factory traffic. For these new signal-boxes provide an additional block post on the main line, thus permitting of closer headway between succeeding trains and lessening the chance of a hold-up in a vital area.

In the signalling of some of these new reception yards a number of features, primarily developed for use in large interlockings concerned with peacetime passenger traffic, have been incorporated. Entrance from the main line to a series of goods reception roads has, for example, been controlled by a single semaphore arm working in conjunction with an electric route indicator, displaying large illuminated figures by day and by night. Economy in cabin space has also been secured by the automatic operation of distant signals; for these latter, no lever is used at all, and the signal mechanism is electrically controlled through the contacts of circuit breakers actuated by the movement of the signals sighted next after the distant by an approaching train. Day colour-light signals have been used for these automatic distants, and the diagram in Fig. 9 shows the aspects displayed in relation to those of the home signal next reached. It will be seen that the "double yellow" indication, as used in multi-aspect colour-light signalling territory, is employed to precede the "green-over-yellow" indication of the semaphores.

In addition to large factories, there are smaller establishments making specialist products to and from which traffic is conveyed by local pick-up goods trains. Business may not comprise more than six to a dozen wagons in and out during the twenty-four hours. Railway connection with an adjoining main line will consist of a single road with points trailing to the direction of traffic. This type of lay-out is indicated in Fig. 10. With ordinary manual block working between stations X and Y, a pick-up goods train can proceed to the junction with the factory line, stop there, and do such shunting as is necessary. On completion of the work it will continue to station Y. But

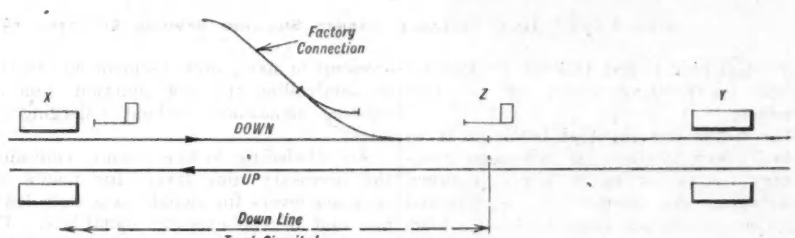


FIG. 10—FACTORY SIDING LAY-OUT

during this time the main line is occupied, and although a pick-up goods would in the ordinary way be sent through only when other traffic was comparatively slack, shunting of this kind is apt to become protracted, and delay to faster trains might occur. It is thus desirable to have means for stowing the goods train and thereby clearing the main line.

To do this the factory connection is brought virtually within the interlocking area controlled by the signal-box at X. The intervening section of line is track circuited, as shown in Fig. 10, and additional signals are installed. With a train requiring to be berthed clear of the main line, the procedure is as follows:—The train arrives at the works siding and draws ahead till the rear brake van is clear of the points, its position being indicated to the signalman at X by track circuit repeaters. One of the train crew then presses a plunger, and on receipt of the appropriate indication in the signal-box the signalman electrically releases the point lever. The factory siding points are then thrown by the train crew operating a ground lever, and the train can then be shunted into the siding. The points are then restored to normal, and after they have been duly locked, traffic can be signalled on the main line. This method of working would be used at places where the pick-up traffic is quite small; at busier places it would probably be desirable to use a goods running loop, as described earlier in this article, to lessen the time taken to berth the local goods train clear of the main line. In all probability the signal Z in Fig. 10 would require to be electrically worked, owing to its distance from station X, but it will be appreciated that the arrangement just described would be very much more economical, both in first cost and in operating expenses, than the establishment of an intermediate block post, with a new signal-box continuously manned.

Railway arrangements have been affected in some localities by the construction of new roads. Conditions have rendered the use of under or over bridges a difficult matter, and for simplicity and speed in execution of the work level crossings are being installed. The signal engineer is once again called upon to provide a safe and efficient means of controlling the traffic. The relative importance of the railway and road have a considerable bearing upon the kind of lay-out. The road, built specially for wartime traffic, can always be assumed to be fairly busy, but it may cross a railway which, even in these times, is infrequently used. In such a case there is no need to install elaborate mechanical mechanism for operation of the gates, which would, of course, require to be interlocked with the signals on the railway. The gates can be left normally open to the road and moved round by hand when the approach of a train is advised by one or other of the signal-boxes terminating the section in which the level crossing occurs. At such a place distant signals only are provided on each side of the gates, and the levers controlling these are only released by mechanical interlocking when the gates are bolted across the roadway. In situations of this kind a very compact operating unit is used, in which a winch replaces the usual signal levers. This winch includes a high gear ratio in the signal-operating mechanism, making it convenient for working, if need be, by a woman gate-keeper.

At busier points the gates require to be operated from a signal-box, which then forms a block post on the railway and must be equipped with home and distant signals. The interlocking of mechanical and electrical functions, so readily accomplished in modern railway signalling practice, has been applied to co-ordinate the working of the level crossing gates and the road traffic signals marking the approach to the crossing. The signals, which are of the usual type used in public thoroughfares, give a much more positive warning that the gates are about to be closed across the road than the bell hitherto used at level crossings. The display to road traffic of the familiar green, yellow, and red indications is regulated by electric interlocking with the gates and their operating gear.

In this article the working of complete trains on the move has been considered. In a further article the application of modern signalling to the sorting and marshalling of goods trains will be described.

(To be continued)

Non-Metallic Chemical Plant

By A. E. WILLIAMS, F.C.S.

No. I

ACIDS in general are sufficiently rapid in action against metals to render their handling and storage in metal tanks by chemical manufacturers an impracticable proposition. There are a few exceptions to this, however; for example, sulphuric acid may be safely handled in lead-lined vessels, while stainless steel has been developed as a highly acid-resisting material. Such metals have long been used successfully in the construction of chemical plant to solve the corrosion problem. Apart from the relatively short life of lead when used for chemical work, and the high cost of stainless steel, these metals are scarce in wartime. Accordingly, it is not surprising that other, non-metallic, materials have been gradually developed for use in the construction of acid-resisting chemical plant, and the mechanical and physical properties of these materials have been progressively enhanced, so that they now compare favourably with metals in regard to these properties, and are superior to metals in certain other directions. To-day in modern British chemical factories we may see stoneware tanks and filters, cooling coils of vitreous silica, glass pipe lines, vacuum vessels and autoclaves with a synthetic resin basis, and numerous other items of plant all made from non-metallic materials.

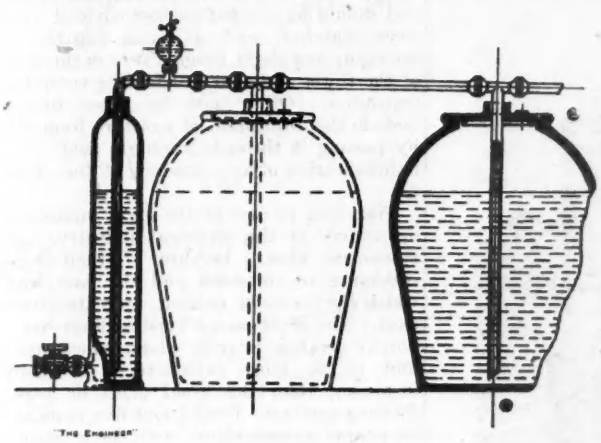


FIG. 1—STONEWARE STORAGE VESSELS

STONEWARE

As a chemical engineering material one of the many advantages of stoneware is its high resistance to corrosion, and it is found in practice that very few chemicals have any action upon it, the chief exceptions being hydrofluoric acid and hot concentrated caustic solutions. The makers of such stoneware do not therefore rely for the maintenance of their business on the periodical replacement of equipment required by their clients, but rather on extending the uses to which stoneware may be applied. That the applications of stoneware have been so extended in recent years is shown by the wide variety of equipment now made of this material, which includes storage vessels and containers, made in one piece with a capacity up to about 500 gallons, pipe lines, towers for absorption, cooling and washing processes, condenser jars, receivers, coils, ejectors, exhausters, pumps, vacuum filters, &c. This extensive use of stoneware has been made possible because of improvements in its mechanical properties. For example, the compression strength of certain stoneware bodies is now equal to that of grey cast iron, and in many cases it is possible to grind it to exact measurements. The adjoining table (Felix Singer, *Chemistry and Industry*, 23.11.34) shows the improvements in mechanical and physical properties of stoneware during the period 1921 to 1933.

Properties of Stoneware

	1921.	1933.
Compression strength, kilos. per square centimetre ...	5816	8210
Tensile strength, kilos. per square centimetre	116	528
Bending resistance, kilos. per square centimetre ...	416	953
Elastic modulus, kilos. per square millimetre	4175	4175
Torsional resistance, kilos. per square centimetre ...	251	323
Impact strength, cm.-kg. per square centimetre ...	1·9	4·97
Abrasion test (loss in cubic centimetres)	3·0	0·6
Water absorption, per cent.	0·5	Nil
Coefficient of expansion ...	$4{\cdot}1\times0{\cdot}10^{-6}$	$0{\cdot}15\times0{\cdot}10^{-6}$
Thermal conductivity, kg. cal. m^{-1}, h^{-1}, ° $C.^{-1}$... ...	1·35	3·95

Owing to its enhanced resistance to high temperatures and improved thermal conductivity, steam-jacketed vessels, with or without agitators, may be made of stoneware.

Acid Storage.—For the storage of corrosive materials, such as acids, it is convenient to employ a battery of stoneware vessels, each holding several hundred gallons, and to connect these vessels together by a series of siphon pipes, so arranged that the vessels can be discharged at one point of the system. This arrangement is illustrated in Fig. 1, which shows the method as employed by Doulton and Co., Ltd., Lambeth, London, S.E.1. Each vessel, including the narrow delivery vessel on the left, is connected to the next one by a siphon pipe. In operating such an installation it is initially necessary to prime each vessel with a liquid. The whole pipe line is next exhausted through the glass connection and sight bulb, whereby the liquid siphons over and distributes itself to the same level in all the vessels. When a bulk supply is added to any vessel in the system siphonic action distributes it equally to all the vessels. Supplies are drawn from the battery through the cock at the base of the narrow vessel, which, owing to its much smaller diameter, causes a quicker fall in the level of liquid in comparison with the level in the vessels. This rapid fall causes the liquid in the vessel next in the line to siphon over into the discharge vessel and this siphonic action is repeated throughout the whole battery of vessels. The height of liquid in the battery is recorded by a float and indicator. Auxiliary plant for working in conjunction with such a battery of stoneware storage vessels may consist of stoneware ejectors, acid eggs, force or centrifugal pumps, and stoneware cocks and pipe lines.

Pipe Lines.—The non-corrosive properties of stoneware are particularly useful with reference to pipe lines, for these are an essential part of a chemical plant, and one in which the interior cannot readily be inspected as is the case with an open vessel. In metal pipes corrosion and its accompanying deposits may have reached an advanced stage before its presence is even suspected, but the inert surface of stoneware neither lends itself to corrosion nor to the accumulation of deposits from the liquids handled. Unlike metal pipes, which require painting periodically if they must be preserved, the stoneware variety needs no protective coating for its preservation. Stoneware piping may have joints of two types, the spigot and socket joint, or ground conical flanges. For most chemical process work the conical flanges are preferred, and in this case the pipes and fittings are coupled together by means of special metallic clips. An example of piping coupled together in this manner is shown in Fig. 2, which depicts some of the pipe lines in

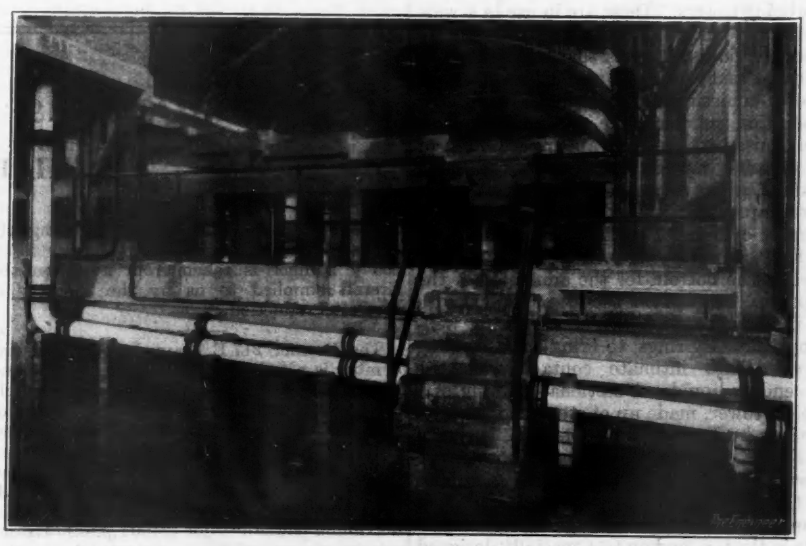
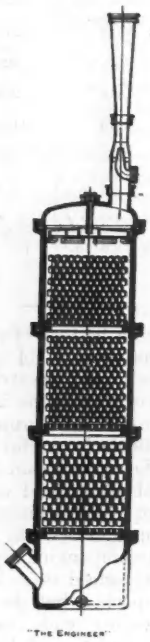
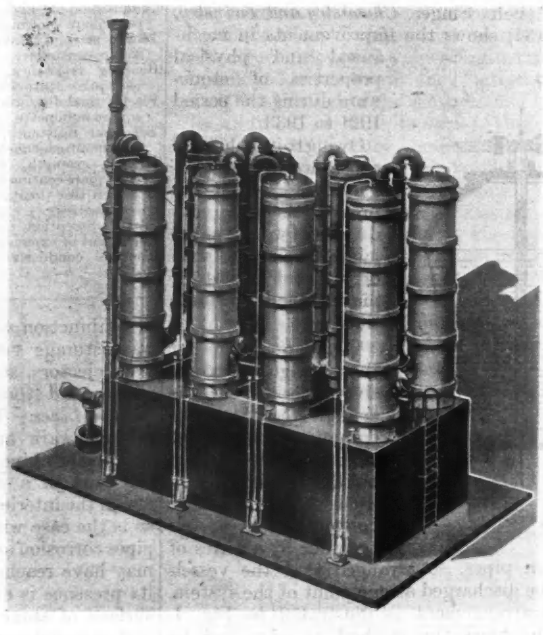


FIG. 2—STONEWARE PIPE LINES IN A PAPER MILL

a paper mill, supplied by Doulton and Co., Ltd. Piping arranged in this way is capable of withstanding pressures much higher than those which normally occur in chemical processes, as, for example, in an acid or bleach line. To alter the pipe circuit entails merely disconnecting the pipe couplings, when the desired new section may be inserted. This makes for speedy alterations to pipe lines, since there are no cement joints to be broken and no spigots to be removed from sockets. The use of stoneware piping is not confined to straight lengths, for the various shapes seen in metal pipes can be made easily in stoneware, including straight and curved junctions, bends, tees, &c., while the cocks for the pipe lines may also be made in the same material. For an installation that is so situated as to be extremely vulnerable to mechanical injury the stoneware pipes, including cocks and other stoneware fittings, may be armoured, which gives them the same immunity as metal pipe lines.





FIGS. 3 AND 4—STONEWARE ABSORPTION TOWERS

Absorption Towers.—Another direction in which stoneware is often preferred to metal is in the construction of absorption or scrubbing towers. These are in use in a wide variety of chemical works, functioning to absorb vapours or gases that may either be valuable and therefore worth collecting, or chiefly undesirable, in which case their absorption prevents the works creating a local nuisance. As the vapours are often of a corrosive nature, stoneware is a good medium with which to contain them. The towers are vertical cylinders, built up of three or more cylindrical sections, having an inlet at the top for an absorbing liquid and an inlet at the bottom for the admission of the vapours. The body of the tower is filled with an inert packing material, such as the well-known Raschig rings, to bring the ascending vapours into intimate contact with the descending liquid. A sectional drawing of a typical tower, made up of stoneware circular sections by Doulton and Co., Ltd., is shown in Fig. 3, the stoneware ejector at the top serving to induce the vapour flow, the inlet for the vapour being seen at the base. Liquid passes into the tower through a centre aperture in the top, and on to a specially designed stoneware plate to ensure even distribution over the top surface of the packing material. The liquid then proceeds by gravity over the whole of the large surface area of the packing material, during which it absorbs the vapours coming up from the bottom and finally runs out at the base of the tower. To cope with large volumes of vapours or gases a series of such towers is necessary, such as the installation by Messrs. Doulton seen in Fig. 4. In this plant the stoneware ejector which draws the vapours into the whole system is to be seen on the left, and arrangements are made for recirculating—and replenishing—the liquid as may be required. The liquid is recirculated in the towers by Pohle lifts operated by compressed air, the pressure of which is conveniently from 5 lb. to 10 lb. per square inch. In place of an air lift of this type a stoneware pump may be used to circulate the liquid. When the towers are operated under suction the ejector may be worked either by a fan, by compressed air or by steam. In operating such towers precautions are taken to ensure that the rate of flow of the gas or vapour is not so high as to cause entrainment of the liquid. The pressure required to carry the gas or vapour through the system depends mainly on the type of packing and the height of the tower, and with stoneware towers the height is generally between 10ft. and 20ft., the diameter being in suitable proportion. If, for some reason or other, the stoneware tower must consist of more than three or four sections it is customary to take the weight of each section under the socket of the pipe, either wood or steel scaffolding being used for this purpose, for the total weight of the tower and its packing material is comparatively high and would put an undue load on the bottom sections. Foundations for the towers need to be adequate to carry their weight when loaded with packing and liquid and should have a flat surface covered with some material, such as sand, capable of taking up any slight irregularities in the base of the tower and also of affording room for expansion. Other uses for these towers include the absorption of moisture from air, by passing it through sulphuric acid; the humidification of air; washing of flue gases, &c.

Filtration is one of the most necessary operations in the chemical industry, and stoneware filters, because of their high resistance to corrosion and the ease with which they may be cleaned, are extensively used. The most recent type of filter has a porous ceramic filtering plate, which users find to be more satisfactory, in many instances, than the usual cloth or paper filtering medium. Until about five years ago all porous ceramic filters, with the exception of small porcelain and kieselguhr tubes used in the laboratory, had to be imported, but they are now manufactured in this country in large quantities. These filtering media are used, among other purposes, for the diffusion of gases into liquids, agitation of liquids by means of compressed air, and for the filtration of water, corrosive acids, &c.

In addition to an increasing use because of its own merits, the present shortage of metals has given an impetus to the installation of stoneware plant. Many types of chemical plant previously made in metal can be duplicated in stoneware in suitable design. Even where corrosive conditions are absent the use of stoneware often means a saving, since its initial cost is usually lower than that of its metal counterpart and maintenance charges are almost negligible.

(To be continued)

The De-Icing Equipment of a Dornier Bomber

THE following information concerning the de-icing equipment of the Dornier 217 E heavy bomber is taken from notes on this aircraft supplied to us by the Ministry of Aircraft Production.

The Dornier 217 E heavy bomber and dive bomber is a twin-engine mid-wing monoplane, with a wing span of 62¼ft. and an all-up weight of approximately 33,000 lb. The maximum speed is 309 m.p.h. at 18,000ft. The engines are B.M.W. 801, fourteen-cylinder, twin-bank radial, air-cooled, fitted with fuel-injection pumps. Each engine develops 1580 B.H.P. at take-off (2700 r.p.m.), and 1460 B.H.P. at maximum power altitude (2400 r.p.m.). Examination of one of these aircraft shows that de-icing equipment is fitted to the wings and airscrews, a hot air system being employed in the wings and a fluid and slinger ring system on the airscrews. Hot air sprays are fitted to the pilot's windscreen and to each of the windows in the nose of the aircraft. No provision for de-icing is made on the tailplane, fins, or aerial mast.

WING DE-ICING

Port and starboard systems are similar, but independent, except for a common control lever, and are shown in Figs. 1 and 2. Hot air is supplied from two muffs round the exhaust pipes behind each engine, and is led through a large lagged pipe in the leading edge. At every rib interspace a small duct taps the hot air supply, the air being led into a narrow space formed in the double-walled leading edge. The

air enters at the bottom of the sandwich and passes forward and upward around the leading edge and escapes into the wing just forward of the main spar flange, and finally escapes to atmosphere through apertures at the aileron hinges. The hot air supply can be augmented by hot air from the cabin-heating system, when this is not required. The wing de-icing is controlled from the cabin by spring-loaded cables running over pulleys and operating a flap valve which spills the hot air overboard when not required, through a pipe emerging under the wing at mid-chord in the fillet outboard of the engine nacelle.

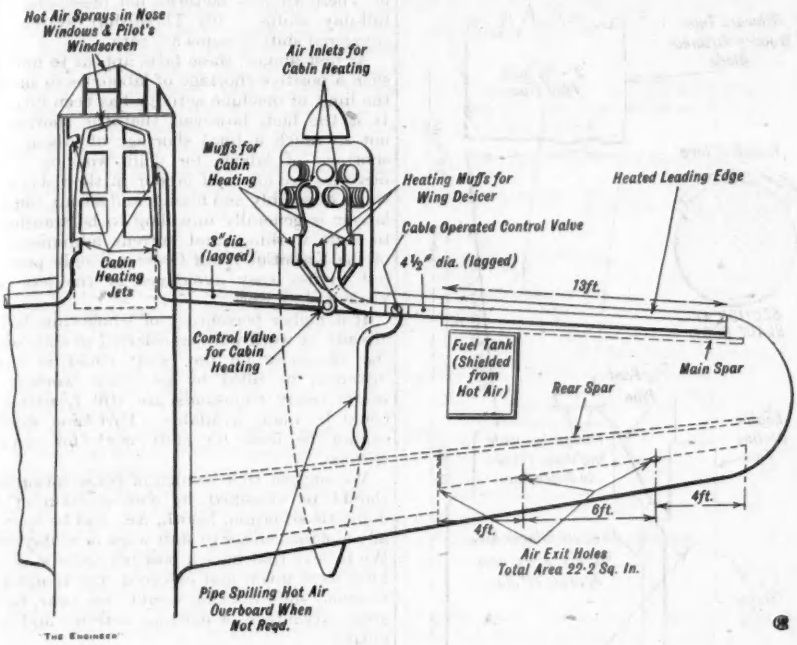
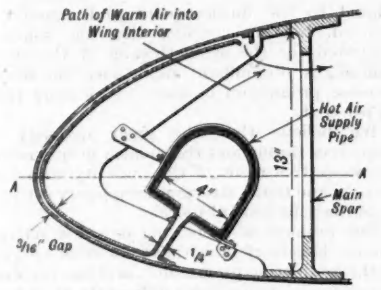


FIG. 1—GENERAL ARRANGEMENT OF HOT AIR SYSTEM



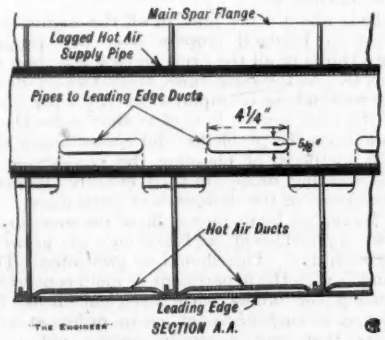


FIG. 2—WING DE-ICING SYSTEM

The muffs are shown diagrammatically in Fig. 3. Separate exhaust pipes from each cylinder are led back inside the cowling to emerge in groups of four and six near the wing leading edge. The heater muffs are fitted to the exhaust pipes from the front and rear top cylinders and take the form of tubes concentric with the exhaust pipes with one end open and the other end ducted into the wing heating system. Small metal tongues are riveted to the inside and outside of the exhaust pipes to assist heat radiation. Air inside the cowling, already warmed by the remaining exhaust pipes, is forced through the muff by pressure in the engine nacelle, which is produced by an engine cooling fan situated behind the airscrew and driven at 1·72 times the crankshaft speed.

HOT AIR SPRAYS AND CABIN HEATING

Port and starboard systems are similar and independent, and are shown in Fig. 1. On each side hot air is supplied from two muffs round the exhaust pipes and is led into the cabin through a 3in. lagged pipe. When not required the hot air is fed into the wing de-icing system, to be used for wing heating, or spilt overboard. The air flow is controlled by a two-way valve, operated by cables from a hand lever in the cabin. A hot air spray is fitted to the pilot's windscreen and is shown in Fig. 4. A small valve in the feed pipe controls the flow to the windscreen spray. A large number of hot air sprays are fitted to the transparent panels in the nose of the aircraft. These consist of seventeen sprays of $\frac{3}{8}$in. tubing with $\frac{1}{16}$in. holes drilled at 1in. pitch, fed by a 1in. diameter pipe. Further cabin heating is by four hot air jets of about 2in. diameter, situated near the feet of each member of the crew.

THE CABIN HEATER MUFFS

Two heater muffs for the cabin system are situated on separate exhaust pipes behind each engine and consist of cylinders concentric with the exhaust pipes and closed at both ends with pipes leading in and out. Inlet pipes of 1½in. diameter take in cold air from a point between the front and rear bank of cylinders, and outlet pipes of 2½in. diameter are joined together to form a 3in. pipe which leads into the cabin heating system.

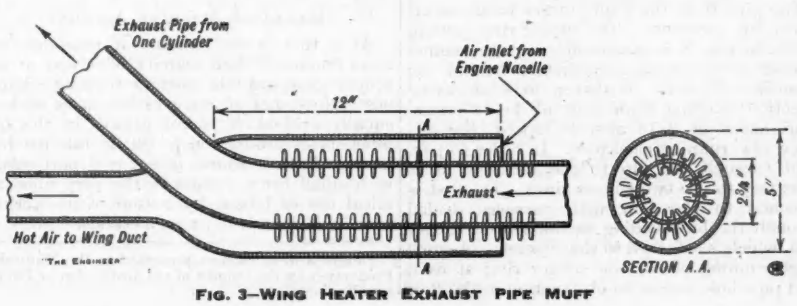


FIG. 3—WING HEATER EXHAUST PIPE MUFF

AIRSCREW DE-ICING

The electrically operated V.D.M. constant-speed airscrews are fitted with wooden blades of the Schwartz type. Airscrew de-icing is by the fluid and slinger ring method. De-icing fluid is contained in a flexible self-sealing tank of approximately 3 gallons capacity, situated on the forward bulkhead of the undercarriage bay on the starboard side, and is forced through the pack type filter shown in Fig. 5, and to the slinger rings by an electrically driven pump. This pump, which is shown in Fig. 6, is placed beneath the tank and is of the diaphragm type. The pump diaphragm is 2½in. diameter, and is

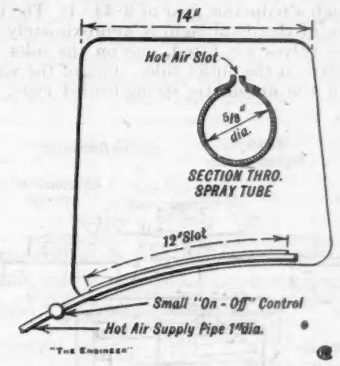


FIG. 4—WIND SCREEN HOT AIR SPRAY

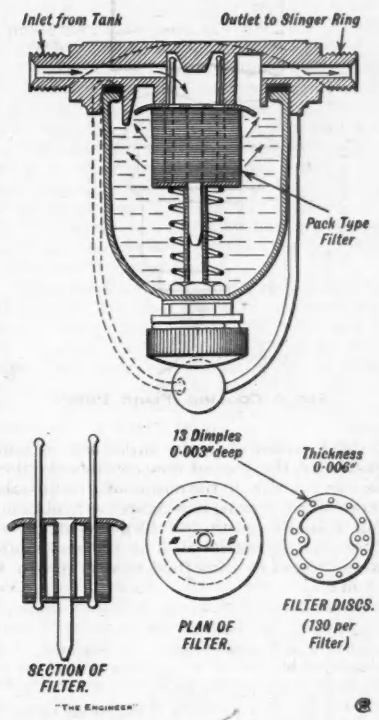


FIG. 5—FILTER FOR AIR SCREW COOLING FLUID

composed of five laminations, three of oiled linen material interspaced with two of oiled silk, and is reinforced on each side with a metal plate approximately 1¾in. diameter. The diaphragm is reciprocated by means of a pivoted bell crank, one end of which is fixed to the diaphragm, the other end riding on an excentric which is driven by an electric motor through a reduction gear of 9·44 : 1. The total stroke of the diaphragm is approximately ¼in. Three valves are fitted, one on the inlet side and two on the outlet side. Two of the valves are of the automatic spring-loaded type, and

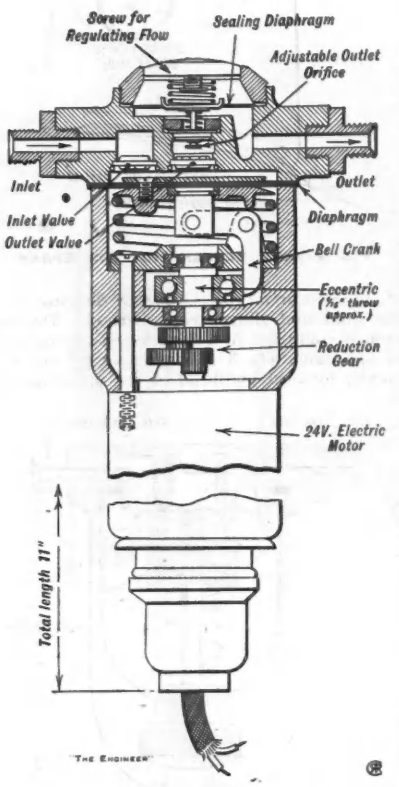


FIG. 6—COOLING FLUID PUMP

the third, which is on the outlet side, is hand adjusted on the ground and controls the flow. This valve is more in the nature of an adjustable orifice. The following flow figures were obtained using a fluid consisting of 40 per cent. glycol, 60 per cent. industrial alcohol. This is similar to the German de-icing fluid used in the Ju. 88 system :—

Back pressure, lb./sq. in.	Flow, pints per hr.	Amps.	Volts.	Remarks.
0	42·3	1·0	22·8	Regulating valve fully open
5	16·9	1·0	22·8	
10	5·3	1·0	22·8	
15	0	1·0	22·8	
				Regulating valve—
0	42·3	1·0	22·8	Fully open
0	25·4	1·0	22·8	Closed one turn
0	7·9	1·0	22·8	Closed two turns
0	5·3	1·0	22·8	Closed three turns
0	3·7	1·0	22·8	Fully closed (3½ turns)

The pipe from the pump outlet branches off to the two airscrews. The slinger ring system, shown in Fig. 7, is complicated by the engine-cooling fan situated immediately behind the airscrew. This fan is driven in a clockwise direction (looking from rear) at 1·722 crankshaft speed or 3·18 airscrew speed, the airscrew also running clockwise. In order to pass fluid through the fan to the airscrew, it is necessary to use two slinger rings. The first is attached to the fan, with passages drilled through the hub leading to the second slinger ring, which is attached to the airscrew. A small ridge running across the slinger ring at each feed pipe hole causes an obstruction in the flow of fluid round the ring and forces it to flow through the feed pipe. From the slinger ring a pipe is led to each of the airscrew blades and feeds a small trough fixed circumferentially to the blade root. Two feed pipes of about ⅛in. bore lead from the trough to the leading edge

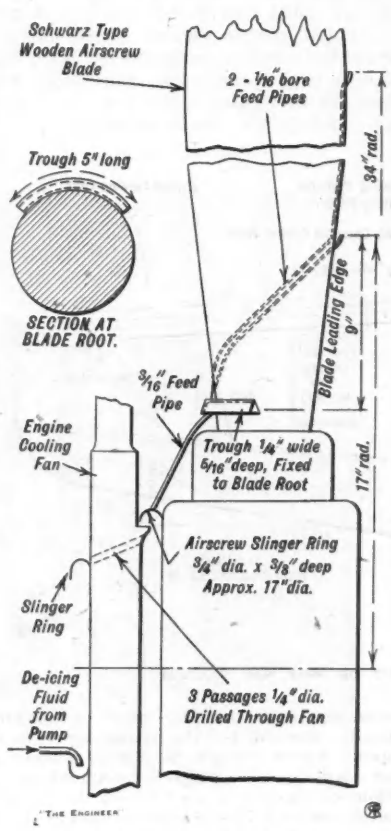

Schwarz Type Wooden Airscrew Blade
2 - 1/16" bore Feed Pipes
34" rad.
Trough 5" long
SECTION AT BLADE ROOT.
Blade Leading Edge 9"
3/16" Feed Pipe
Engine Cooling Fan
Trough 1/4" wide 5/16" deep, Fixed to Blade Root
17" rad.
Airscrew Slinger Ring 3/4" dia. x 3/8" deep Approx. 17" dia.
Slinger Ring
De-icing Fluid from Pump
3 Passages 1/4" dia. Drilled Through Fan
THE ENGINEER

FIG. 7—SLINGER RING SYSTEM

and are buried under the protective covering of the blade. The pipes then run along the leading edge, under the brass sheath, one emerging at 17in. radius and the other at 34in. radius.

Increasing Production Without Increasing Facilities*

IT will now be generally admitted that sheer expansion is nearing the limits imposed by labour availability, and that expansion is no longer the most predominant phase of the production problem. Indeed, with the entry into the war of the United States of America and the Russian need for machine tools, it is clear that our new focus of effort in home production must be to increase output without any further increase in plant facilities.

There are broadly only four ways by which this may be done, and this memorandum is written to direct attention to these fields. The four ways are :—(1) By increased machine activity ; (2) by simplification of design ; (3) by rationalisation ; (4) by improved manufacturing methods.

INCREASED MACHINE ACTIVITY

At a time when scarcity of machines was more dominant than scarcity of labour, it was proper to regard idle machine tools as calamitous. Now that scarcity of labour is at least equally critical, it is not always in the best interests of production to fill up idle machine hours. Such a course often, and particularly with small firms, results in the very uneconomical use of labour by reason of its working with inefficient production methods.

Generally, greater machine activity will mean greater total output. What, then, are the present facts regarding this vital machine activity ? (*a*) The majority of engineering machine shops are working a nominal two-shift system of, say, fifty-five hours per shift week. (*b*) Many shops are working a day shift only. (*c*) There are new factories not possessing even full-day shifts. (*d*) Three-shift systems or staggered shift systems are rare.

At first glance, these facts appear to indicate such a positive shortage of labour as to suggest the limit of machine activity has been reached. It is the fact, however, that the shortage is not so much a total shortage of labour as a shortage of labour for shift working. Few factories are short of labour in their day-shift shops (assembly and fitting, and so on), but this labour is generally unwilling to be transferred to shift working, and current administration of the Essential Work Order not only permits, but invites easy avoidance of the less convenient shift work.

If a higher percentage of whole-time labour already at work were transferred to shift work, the vacancies on day shift could in many instances be filled by part-time workers, of whom many thousands are still available or could be made available. Part-time workers cannot be used for shift work for obvious reasons.

We suggest that women of conscription ages should be classified by consideration of the domestic situation, health, &c., and be specifically assigned either to shift work or to day shift. We believe that once a positive decision of this kind were given and enforced, the temptation to avoid shift working would disappear, to the great advantage of machine activity and total output.

At present the weakness of national service officers, many of whom are hopelessly overloaded in exercising their powers, encourages not only the improper use of the medical certificate, which is unfortunately very common, but also encourages absenteeism and lateness. The loss in machine activity commonly amounts to between 5 and 10 per cent., and this represents a similar or often a greater loss in total output. This matter is mentioned because it is related to the former point and cannot be omitted, but we consider that the solution suggested for the strengthening of the shift-manning is of dominant importance, and would increase production in many cases more than 20 per cent.

We believe that the great majority of employees throughout the country deeply resent the weak treatment of the minority who misbehave, and that a stronger disciplinary attitude would benefit general morale.

The problem of increasing machine activity cannot be attacked without mention of gaps in the production programme, and this involved element in planning bears differently upon large and small shops, upon main contractors and sub-contractors.

Only about 4 per cent. of all the engineering firms in England employ over 500 people. Two-thirds of all the firms employ less than 50 people. At the same time, about two-thirds of the total labour is employed in only 4 per cent. of the total firms. It is clear that under these conditions the problems, and consequently the best methods, of planning the production of the few big units must be entirely different from those of the thousands of small units.

Many, but by no means all, of the small firms are very inefficient, and new ones are growing up each day. This should be prevented. The fault is with the department or main contractor placing the orders with inefficient firms, for so long as such firms can secure orders at high costs they will generally oppose voluntary measures towards grouping or sole dependance upon one parent main contractor. It is unfortunate that Government costing departments appear to concentrate upon the limitation of profit rather than of cost.

All these factors bear directly upon the machine activity of the small firm, which is frequently low, because of the inefficient allocation of load to their capacity. We do not think the production programmes of the small units can ever be efficiently and individually planned

* From a memorandum presented to the Minister of Production by the Council of the Institution of Production Engineers.

from a central headquarters, much less from a multiplicity of Supply Ministries. We recommend that the problem be tackled on a decentralised basis, either by a wide extension of the powers of district clearing centres, or, better, by the formation of District Production Groups, responsible for the assignment of loads to capacities within the groups. In this case, it follows that the Supply Ministries, in relation to such production groups, must be regarded as buyers in the broadest sense. They must develop and specify the particulars of the needed products and the groups are the "firms" from whom they are to buy and with whom they are to agree their production programmes. We visualise each group as a single firm, with the same freedom of movement of labour and plant within the group as is enjoyed by a single firm within itself.

SIMPLIFICATION OF DESIGN

It is the normal thing when increases in production of an article are called for to follow the line of least resistance, and attempt to increase the machine hours assigned to the job *pro rata* to the increased production required, thus limiting the production to the total machine hours available. An alternative which has proved richly productive in certain instances is to modify the design both to facilitate production and to eliminate superfluities.

This is not a field which permits setting down rules or even guides, and success is largely dependent on the experience of the individuals concerned in each case. Any reasonably competent production engineer, however, will find scope for effort of this kind in probably every separate product with which he is concerned.

As regards changes in design to facilitate production, this is not a static question in which a single review will yield all the potentialities. The actual experience of a production order will suggest possibilities for repeat orders. An increase in the required rate of production will influence design, bigger quantities invariably encouraging simplification of design, and reduction of machine hours.

Perhaps the more important side to this question is the elimination of superfluities. There is a tendency for designs to include elaborations which do not seem justified, bearing in mind the production load they represent. A few examples in this field are given below :—

(1) *A Bren Gun Part*

		£	s.	d.
Original cost per 100 :	Material	4	7	6
	Man/machine hours	234	7	6
		£238	15	0
Cost per 100 after redesign as a simplified pressing :				
Material		1	10	0
Man/machine hours		10	0	0
		£11	10	0

This case represents a saving of 797,000 machine hours, equivalent to £204,975 over an order of 90,000.

(2) *Aircraft Part*

		£	s.	d.
Original cost per 100 :	Material	1	0	2
	Man/machine hours	4	4	10
		£5	5	0
Cost per 100 after redesign all as one unit :				
Material		0	14	2
Man/machine hours		2	16	0
		£3	10	2

This case represents a saving of 5407 machine hours, equivalent to £1346 over an order of 95,000. Total saving of material and machine hours over a quantity of 95,000 is £1631.

(3) *Percussion Fuse Part*

		£	s.	d.
Original cost per 100 :	Material	0	2	6
	Man/machine hours	0	12	6
		£0	15	0
Cost per 100 after redesign and die-casting :				
Material		0	1	7
Man/machine hours		0	3	10
		£0	5	5

This case represents a saving of 77,480 machine hours, equivalent to £17,334, over an order for 4,000,000. Total saving of material and machine hours over a quantity of 4,000,000 is £19,180.

(4) *Two-pounder Gun Mounting Part*

		£	s.	d.
Original cost per 100 :	Material	250	0	0
	Man/machine hours	850	0	0
		£1100	0	0
Cost per 100 after redesign :				
Material		68	6	8
Man/machine hours		180	16	8
		£249	3	4

Apart from saving in machine hours and cost, this redesign has also eliminated the use of high-grade alloy steel.

(5) *Six-pounder Breech Mechanism Part*

		£	s.	d.
Original cost per 100 :	Material	1	2	6
	Man/machine hours	15	12	6
		£16	15	0
Cost per 100 after redesign :				
Material		0	12	6
Man/machine hours		3	2	6
		£3	15	0

Practically the whole of the machine hours saved were milling machine hours.

(6) *Standard Airframe Part*

		£	s.	d.
Old method—				
Made from bar per 1000 :	Material	4	1	9
	Labour	52	9	10
		£56	11	7
New method—				
Made from sheet per 1000 :	Material ...	2	17	11
	Labour	15	11	0
		£18	8	11

This case represents a saving of 13,100 machine hours, equivalent to £3812 10s. over an order for 100,000.

(7) *Air-borne Radio Part*

	£	s.	d.
Old method—			
Two off per unit pulley casting, cost per 100 units	7	1	8
Two off per unit brass gear, cost per 100 units	17	10	0
Six off six B.A. screws, six off six B.A. locking washers, cost per 100 units ...	2	10	0
	£27	1	8
New method—			
All above parts replaced by two off per unit pulley and gear die-castings, cost per 100 units	5	8	4

This case represents the elimination of all machine hours with the substitution of a die-casting; £4333 6s. 8d. saved over an order for 20,000.

We particularly emphasise the savings in raw materials which have been realised in each of the above examples, making the changes doubly advantageous.

The need for interchangeability is frequently cited against redesign, although in the cases quoted it was not affected. In view of the advantages to production, however, it is a question whether net gains would not often be realised even at the cost of loss of interchangeability.

We recommend that the Supply Ministries should, as a matter of policy, devote constant attention to the potentialities of modifications to design in the case of all articles in continuous or big quantity production, and that this policy should always be adopted when increases in output are required. We believe the formation and extension of product groups is beneficial in this field of technical interchange of ideas. Product groups, in this case, need not control the placing of orders, since their function is mainly that of technical co-operation.

RATIONALISATION

By rationalisation we mean concentration so that plant, attention, and effort are expended upon fewer things. The reduction in the variety of goods produced in each plant can be effected either by (*a*) extending standardisation on fewer types, or (*b*) by subdividing production between fewer firms. Each firm then produces greater quantities of fewer types.

Let us consider for a moment the effect of multiplicity of variety in each production unit, and in order to draw out the significance of the matter, let us assume that the number of varieties of product are to be halved, in a typical organisation, while the total weekly value of production is to remain unaltered.

Comparable advantages would, of course, also arise in Government production departments affected.

Attention tends to be focused so narrowly upon the shortage of production labour that the importance of the so-called non-productive staff, which is even scarcer, is not fully realised. Much of the non-productive work in each engineering factory is highly skilled work, and this effort is just as surely dissipated through over-diversified production as the time of skilled tool makers or other skilled producers. Productive capacity is not to be measured in machine hours alone, but also in administrative capacity, production planning capacity, production engineering capacity and even in skilled clerical capacity. Efficiency in big production shops cannot exist without the skill and adequacy of the corresponding production planning and administrative effort. If there is a national shortage of skilled management, as of almost every other skilled occupation, let the same care be taken to avoid its wastage or dissipation as is emphasised for the skilled producer.

We cannot say in so many words what is an optimum span of variety of products for each establishment; the equation is too involved. We can, and do, say that the optimum is far from being achieved in most factories other than those making a single special product for which they were created. We know that the resulting weakening of concentration upon the problems of each product represents a real and important loss in production. We believe that the spreading of contracts under the influence of bombing risks has been overdone, and, in addition, that a policy of planned concentration of production, within reasonable limits, would result in a significant reduction in the variety of products in many works, with a corresponding increase in efficiency.

We must emphasise strongly that production is still largely controlled by tool-making capacity, and failure to rationalise is a great source of unnecessary tool load.

We recommend that most serious reconsideration be given to the abandonment of the "safety first" policy in spreading contracts, and that the general policy should be rather to concentrate production as much as may seem justified. While a single course of supply for any article would, of course, be inadequate, we recommend that two or three would often be sufficient. Where additional sets of tools exist, their lodgment in dispersed locations would serve as an additional insurance.

Where contracts are to be split because a manufacturer has insufficient spare capacity to undertake the whole, we particularly urge that a review should be made of his whole programme. Efforts would then be directed towards planning for a maximum concentration of programmes by pairing up some other commitment with a similar contract elsewhere.

We have a strong conviction that the placing of production programmes is a highly specialised matter, and that it will only be well done with at least the close advice, if not the direction, of persons thoroughly understanding the principles of production.

Above all, we beg that if manufacturers do run into production gaps, they should not be handed out almost anything "to keep them going." Such panic measures create just the troubles which give rise to production gaps.

POTATOES AND PAPER.—America is waking up to a possible shortage of paper. The head of the Maine Department of Agriculture has appealed to Eastern railways handling Maine potato tonnage to salvage paper by leaving lining papers on the sides of cars reaching terminal markets. The trade practice in the past has been to clean potato cars thoroughly of all paper linings upon unloading at receiving markets and to destroy the paper. Under the new plan large quantities of lining paper could be saved and returned to be used again in the same cars. From 1,500,000 lb. to 2,000,000 lb. of lining paper are required annually for this branch of transport.

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CHANGES OF ADDRESS

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INCREASING PRODUCTION

SEVERAL interesting subjects are discussed in the memorandum presented to the Minister of Production by the Institution of Production Engineers, excerpts from which may be found on another page of this issue. It cannot be said that any new ideas are introduced, but it is no doubt a good thing to reinforce old ideas by new arguments. In this case that observation applies particularly to the examples which the Institution is able to give of the saving in time and money effected by the simplification of design. The items listed are for the most part small in themselves, but if in any given machine there were many parts all subject to simplification and modification, a great saving would result. The need for the examination of war production with a view to the elimination of unnecessary work and finish, and to the employment of cheaper materials has been stressed several times in these pages. We welcome therefore the support given by these actual examples of saving. Another striking instance has been revealed in the past two or three days by the release of particulars about the Sten gun, which, owing to rigid simplicity of design and avoidance of finish, is being produced in large quantities at no more than £2 apiece.

Whilst it is probable that few engineers, save those who by a long tradition are die-hards for superlative finish and imperishable materials, will fail to endorse the arguments for simplification set forth by the Institution, many will not agree so cordially and unreservedly with other parts of the memorandum. This will be the case notably with regard to small works. There are many arguments for them, and as many against them, and no one has yet been able to decide, upon the available evidence, whether they are, in fact, advantageous or quite the reverse. According to the Institution, only some 4 per cent. of all the engineering firms in England employ more than 500 people, and two-thirds of all the firms employ less than 50. On the other hand, nearly two-thirds of the total labour is employed in only 4 per cent. of all the firms. We fancy these figures are based on data available before war, but even if some modification of them be necessary, the general picture of a great number of small and smallish firms and a few great corporations remains true. Hence, the problem of the Minister of Supply is to devise means of making the best use of the small manufacturers. The Institution admits that not all of these are inefficient, but it is opposed to the increase in the number in the present circumstances. We have all heard of little mushroom firms which have managed to get hold of a few machines and have secured contracts. It seems likely that such concerns are inefficient, measured by the standards applied to larger organisations, but unless they are hampering output, their contribution to the war effort must not be contemned out of hand. There are good examples and bad; instances of both have been brought to our attention. Certainly small firms, whether of new growth or established of old, cannot safely be condemned just because their methods and organisation are not the same as those of the few and great. They need handling in a special manner to develop their qualities. The Institution speaks no doubt from experience when it expresses a doubt that "the production programmes of the smaller units can ever be efficiently and individually planned from a central headquarters, much less from a multiplicity of Supply Ministries." The fact is that the smaller the firm, the more individualistic it is, and the greater the need of local knowledge of its personnel and capacity.

Viewed in this light, the recommendation of the Institution that District Production Groups should be set up for the assignment of orders would merit consideration, were it not that it appears to have been anticipated in the Citrine Report published a few weeks ago. That report recommended that the Regional Boards should be reconstituted with the purpose of effecting the devolution of authority. Each of the Boards, eleven in number, would be responsible for the allocation of orders in its own region, and would be expected to be intimate with the capacities of all firms, great and small, within that region. This recommendation was accepted by the Government, a Central Committee has been already set up, and the appointment of the chairmen of the Regional Boards was announced on Tuesday last. It would appear therefore that in this respect the proposals of the Institution of Production Engineers have been anticipated.

The Locomotive Stoker

WHETHER mechanical stoking will ever form a decided feature of British locomotive practice is open to the greatest doubt, but there seems every likelihood that in orders for export much more will be seen of it than hitherto. Little reflection can be cast upon British locomotive builders by an admission that practical knowledge of stoker design and construction is almost negligible, but if many of the post-war export orders require power firing apparatus, this lack of knowledge may lead to inferior and out-of-date practice being perpetuated, for there seems to be evidence that practical solutions to the mechanical stoking problem have reached a a point onward from which they may widely diverge.

With large locomotives of the rigid-frame, Garratt, and Mallet types, the full potential boiler capacity can be realised only if a mechanical stoker is incorporated. Hitherto the sprinkler type has been nearly universal, although the application of the Crawford underfeed stoker to numerous engines on the Pennsylvania Railroad in 1913–15 must not be forgotten. It seems that the sprinkler type fits the locomotive requirements of simplicity, reliability, and comparatively small bulk and weight better than underfeed and travelling grate patterns, and the limit of its delivery has not yet been reached. For example, the 2–8–8–4 Mallets of the Northern Pacific Railroad burn up to 30,000 lb. of coal an hour on certain duties, but the specification for the stokers called for the even distribution over the 184 square feet of grate area of 45,000 lb. of semi-bituminous coal an hour, and this performance was attained on test. Yet there appear to be certain restrictions to, and errors in, the normal applications of sprinkler stokers. To begin with, they are invariably of the rear-delivery type, attached to the fire-box back plate; and the majority of them deliver the coal at such a height above the grate that at high firing rates — and consequently under strong draught conditions—a goodly proportion of the coal, impelled by steam jets, is pulled straight into the tubes. Hence the loss through unburnt fuel is considerable. This is not surprising in view of the gas velocities of 200 to 250 m.p.h. above the end of the brick arch, which are found in big locomotives working moderately hard. Even with the retention of the rear-delivery sprinkler type an improvement in boiler efficiency could be obtained if the point of delivery could be lowered to a level of, say, 14in. or 15in. above the grate bars, and at high firing rates the improvement ought to be considerable. In

relation to fire-box events, views have been expressed that the sprinkler stoker is inherently incapable of providing the conditions necessary to give a high radiant heat absorption, and that with it there is a critical rate of turbulence of the fire-box gases above which unburned fuel losses become prohibitive, and which would not be present with other types of stokers. Some of the truth in the first of these opinions can be recognised easily by the realisation that fresh coal is spread more or less evenly over the whole grate area, and not over a small section of it, as would be the case if a travelling grate stoker could be used. The loss of unburned fuel engendered by the steam jets of sprinkler stokers delivering the crushed fuel into the furnace across the gas stream almost at the point of maximum gas velocity can be conteracted in two ways. First, by the admission of secondary air into the combustion chamber, so that oxygen may be provided to complete or assist the burning of particles being whirled through to the tubes—a method which need not be confined merely to locomotives with the sprinkler type of equipment, but is applicable also to hand-fired engines. Secondly, by the adoption of either underfeed or front-delivery sprinkler stokers. Probably the underfeed class needs too much room for practicable installation in steam locomotives, but tests on the Baltimore and Ohio Railroad with a front-delivery stoker showed efficiency and capacity results which were most encouraging. The feeding members were surrounded by small vertical protecting grate bars, which in their heat exchanging effect pre-heated the supplementary air. And to this feature, plus the long and reversed path which the coal particles had to follow before they reached the boiler tubes, were attributed most of the coal economy and increased boiler capacity.

Some people have wondered why automatic stoking, which is familiar practice in America, is never found on British railways. The answer is fairly simple and has been supplied by the Americans themselves. For any grate less than 60 square feet in area they say that it does not pay to employ stokers. Few British engines have grates even approaching that size. Even the Beyer-Garratt banking engine of the L.N.E.R. has only 56½ square feet, and the grates of the "Coronations" are only 50 square feet. Broadly speaking, it may be said that automatic stokers, as so far developed, are not suitable for the relatively small engines appropriate to British railway conditions. Admittedly, hand firing a 40ft. or 45ft. grate is hard work. On the other hand, there is no question that it is more economical than machine firing, partly because it may avoid the losses of fuel to which reference has been made, and partly because a good fireman can use discretion in the placing of the coal in the box.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ENGINEERS IN THE ARMY

SIR,—Your second Leader of June 19th makes an astounding insinuation in the form of a query that I feel bound to answer.

You take, as an example of the need of a Mechanical Engineering Adviser, the case of gun and carriage. So far, excellent—in theory!

But the question, "Are not the mechanical engineering problems at least as important as the ballistic?" exposes ignorance as to the birth of a gun and insinuates that the design is considered purely ballistically and not as a problem of mechanical engineering.

In actual fact, the requirement of external ballistics, being "what the Service needs," enables a solution for internal ballistics to be given to or calculated by the gun designers. The gun has to withstand these internal ballistics to produce in the projectile the required external ballistics.

From that moment the project is entirely one of mechanical engineering—it is, in fact, the only problem, and is tackled by a team of users and designers of proved experience. A team, too, that is well abreast of the times.

No, the need is not for someone of engineering ability to advise on a specialised job, of which he has no previous experience. As we have already seen, a little learning is most dangerous in gun design. The need is for the user of proved technical experience to be at the elbow of the General Staff to advise as to "what the Service needs" in the knowledge of what, with youth at the helm, the Service can and should have, *i.e.*, something modern.

Where is the Master-General of Ordnance? Defunct, as has been our policy in weapons.

SPES MELIORIS ÆVI.

June 25th.

[May we suggest that our correspondent has rather missed our point? We were contrasting the Government's addiction to science with its neglect of mechanical engineering. The question was a rhetorical one, used as an example of this contrast. What our correspondent says about the design of the gun and its carriage supports our argument as a whole.—ED., THE E.]

Sixty Years Ago

OUR FLEET AT ALEXANDRIA

WRITING in our issue of July 7th, 1882, we speculated concerning what effect the guns of our Fleet then assembled at Alexandria would have on the forts of that harbour if it were found necessary to bombard them in order to ensure the submission of Ahmed Arabi and his military following. For the third time since the beginning of 1879 foreign warships had assembled at Alexandria, with the object of quelling threatened disturbances of the Khedive's rule. In 1879 and 1881 French and British warships co-operated in the demonstration, but on each occasion they withdrew without firing a shot and without producing much impression on the unruly members of the Egyptian populace. In May, 1882, twenty-six warships, representing ten different nations, were sent to the port. Exactly one-half of them were British. Our force, consisting of the Channel Fleet under the command of Sir Beauchamp Seymour, comprised the "Alexandra," "Sultan," "Superb," "Monarch," "Invincible," "Penelope," "Inflexible," and "Temeraire," and five gunboats, including the "Condor." The guns in the Egyptian forts were, we said, believed to be 12-ton and 18-ton muzzle-loading weapons, purchased from this country in 1867, and subsequently. We believed the armour of our ships was sufficient to enable them to face the fire of those guns with great confidence. As for their offensive power, we were satisfied that the 18-ton and 25-ton guns with which most of our warships were equipped would be able to silence the forts. We thought, indeed, that one or two shots from the "Inflexible," which carried four 80-ton guns, would be a sufficient warning to cause the forts' defenders to give in without further expenditure of ammunition. We were, in short, quite sure that the guns of the ships would overcome the guns of the forts. . . . On June 11th over 100 people, including an officer and two seamen, were massacred in the streets of Alexandria almost under the guns of our ships in the harbour. Subsequently, great activity was observed in the forts with the clear object of improving their resistance to attack from the sea. On July 10th Admiral Seymour sent an ultimatum to the Egyptian military commander to discontinue these preparations immediately and surrender certain of the batteries. The reply received was unsatisfactory, and at 7 a.m. on July 11th, the population and the foreign warships having been duly warned of our intentions, the British Fleet opened fire on the forts and earthworks.

Regional Controllers of Production

IN the House of Commons on Tuesday, June 30th, Mr. Oliver Lyttelton, the Minister for Production, announced that the new regional organisation for production would begin its operations on Wednesday, July 1st, and that the following are the names of the Chairmen of the Regional Boards, who are also the Minister's Regional Controllers:—London and South-East, Mr. C. B. Colston, chairman and joint managing director of Hoover, Ltd.; Southern, Mr. John W. Howlett, chairman and managing director of Wellworthy Piston Rings, Ltd.; South-Western, Mr. H. I. C. Rogers, joint managing director of Brecknell, Munro and Rogers (1928), Ltd.; Wales, Mr. Percy Thomas, Past-President, R.I.B.A., formerly Welsh Regional Controller, Ministry of Supply; Midland, Colonel H. B. Sankey, managing director of Joseph Sankey and Sons, Ltd.; North-Western, Mr. Loris E. Mather, M.I. Mech. E., chairman and managing director of Mather and Platt, Ltd.; Scotland, Mr. Lewis J. B. Forbes, A.M. Inst. C.E., M.I.E.E., managing director of Triplex (Northern), Ltd.; Northern, Viscount Ridley, Director of Producer Gas Vehicles in the Ministry of War Transport, director of Consett Ironworks, Ltd., and the L.N.E.R.; East and West Riding, Mr. Charles H. Crabtree, chairman and managing director of R. W. Crabtree and Sons, Ltd.; North Midland, Mr. Harold H. Berresford, managing director of Staveley Coal and Iron Company, Ltd.; Eastern, Mr. H. Weston Howard, managing director of Hayward Tyler and Co., Ltd. Speaking further on the constitution of the Executive Committees, Mr. Lyttelton said that he had received deputations representing the Federation of British Industries, the British Employers' Confederation, and the Trades Union Congress, which had expressed the unanimous opinion that the Vice-Chairmen of the Boards should be members of the Executive Committee. He had considered these representations, and, with the full agreement of his colleagues, had decided to appoint the Vice-Chairmen as members of the Executive Committee forthwith.

BOOKS RECEIVED

Steam Flow Through Safety Valves. By E. K. Falls. U.S.A.: Ohio State University, Columbus. Price 1 dollar.

On Growth and Form. By D'Arcy Thompson. London: Cambridge University Press, 200, Euston Road, N.W.1. Price 50s. net.

Engineering Mechanics. By B. Low. London: Longmans, Green and Co., Ltd., 43, Albert Drive, S.W.19. Price 12s. 6d. net.

Press Tool Practice. By P. S. Houghton. Part 2. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 21s. net.

Mathematics: Its Magic and Mastery. By Aaron Bakst. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 21s. net.

Mechanical Refrigeration. By Hal Williams. Fifth edition. London: Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, W.C.2. Price 30s. net.

"*The Shipping World*" *Year Book.* 56th annual edition. London: *The Shipping World* Offices, Effingham House, Arundel Street, W.C.2. Price 25s. net.

Towards the Financial Engineer

By W. F. KISSACK, A.C.A.

MAY I—as a student of the broader aspects of finance—express approval of Mr. I. V. Robinson's opinion that engineers are "... just the class who should understand the situation and not be side-tracked by the suggestion that finance is a complicated question—to be left to the experts, the bankers and the financial houses."*

That we need a revised financial organisation and technique is certain. Both this new organisation and new technique must be conceived and developed on the basis of certain clear-cut principles and statements, the more important of which are :—

(1) The real productivity factors are brain power, man power, machine power and natural resources.

(2) In order to assist the production, distribution and consumption of goods, services and capital assets, we have invented a device of book entries, tickets and metal coins which we have named Finance.

(3) There is no such thing as financial security, or the strength of financial resources. Security and strength can only reside in realities—never in the degree of efficiency of a bookkeeping device.

(4) A financial crisis is, above everything else, a manifestation of failure on the part of the men who direct the financial operations.

(5) The task of those men is to exercise their technical skill in such manner that when economic action (big or small, producer or consumer) is desirable in the interests of the community, and the real productivity factors are there, that money (*i.e.*, mobile purchasing power) is also there. That, all that, and nothing else but that.

(6) The monetary profit motive (and salary and wage motive) must be replaced by a real reward motive (shelter, food, defeat of the enemy, promotion, freedom of leisure hours, &c.), in which the recipient clearly understands that the money he receives is only part of a useful ticket-cum-bookkeeping device, which can be regulated by human will.

Already we are catching glimpses of the truth of Mr. Robinson's assertion. But if we go further and contrast the organisation and technique needed to operate the financial invention understood in its true function, with the existing organisation and technique built up on the conception that money is a form of wealth, then the case for financial operatives who are engineer-minded, as opposed to custodian-minded, is striking.

It may be wondered why more attention has not been paid to that point by professional economists. There are, to my mind, two main reasons :—

(1) In seeking a financial remedy to our economic troubles, economists have focused too much attention on impersonal schemes, systems and formulæ, and not enough on the attitude of mind and the organisation of the men who operate the financial mechanism.

(2) The economists' approach to the study of the financial invention has been mainly static, instead of dynamic.

I develop briefly those two conclusions, each in turn, below.

Defects in Organisation

It may be said—in so far that it is possible to generalise in the matter—that since 1925 the country's financial policy has been decided by the Treasury and put into effect by the Bank of England through the intermediary of the Big Five. But those major institutions, together with the individual building societies, insurance companies and other financial units, still operate in many instances as distinct entities, each striving for individual success within its own sphere. It is no untruth to say that the brain power of a large section of the accountancy profession to-day is pitted, not against Hitler, but against the brain power of the Inland Revenue ; the intricate E.P.T. texts and computations provide the opportunity for a strenuous battle of wits, in which each side strives to the utmost to save money from the other side.

The traditional conception that money-making is an end in itself has smoke-screened the necessity of a team spirit and unity of command in the financial organisation of the nation. A comparison between the structure of our military and financial organisations is helpful in drawing attention to the deficiencies which are bound to result from this absence of *esprit de corps* :—

(*a*) What results could we expect from the Army if, for instance, the men serving in the artillery, in the infantry and in the Service Corps had separate ideas of their own, and set about their operational tasks accordingly ?

(*b*) Comparing—at the lower end—the different financial units with the specialised Army units, and—at the top end—the economists with the military strategists, we are struck by the non-existence of a Financial General Staff, as a counterpart to the military Operational Command. The Bank of England or the Treasury are, indeed, far from fulfilling such a function.

Before dealing with the aptitudes and the type of mind required in the individual operative, it is necessary to consider the second conclusion

The Dynamic Approach

The outstanding feature of the financial invention is the flow of purchasing power. A brisk traffic of goods and services towards ultimate consumption depends to a large degree on the skill exercised in circulating adequate purchasing power.

The orthodox approach to finance is static, fragmentary and superficial. It speaks, not of circulation, but of equilibrium. The commercial application of classical financial doctrine is symbolised in the balance sheet. Based on the conception that money has value (whether dear or cheap is a matter of degree inside a wrong principle), orthodox practice has also been sadly influenced by what may be termed the "Maginot complex." Those proud references to the "unassailable strength of our financial position" in the annual speeches of some financial (as distinct from technical) leaders of industry can be unpleasantly associated with the decayed doctrine which has meant disaster upon disaster for us in the military field.

Progressive thought has for some years been focused on conceiving the fourth dimension—*i.e.*, movement through space and time—as a basic operating element. As might be expected, this idea originally found expression in the works of great thinkers. The Impressionists were inspired by it ; the landscapes of Monet, for instance, convey the impression, not just of trees, but of the wind in the trees. From art, the notion spread to science and other spheres. Present-day biology is essentially a science of the change of form in natural life. The Nazi High Command's conception of the Wehrmacht is that of a curtain of fire which advances.

The specialised progress engineer, who is concerned with moving as distinct from making, becomes a key technician in the different spheres of human activity. The process is the basis, the background on which plans and action are formulated.

It is likely that this school of thought will, sooner or later, invade and dominate the sphere of financial activity. The old idea that banks are solid fortresses of wealth will slowly make room for a conception of banking as a network of purchasing power stations and sub-stations, in which the Central Bank is the generating and supervising centre. Bank operatives will gradually develop into specialists at circulating money in such manner that adequate quantities of this purchasing "juice" reach the right places at the right time. These banking technicians, with their price controlling, auditing, fiscal and other financial colleagues, will in all probability grow into a national organisation of financial engineers, acting as a public service.

Then, and then only, will the shoe manufacturer be able to concentrate, not on making profits, but on making shoes. The farmer will concentrate on tilling the land and breeding stock, and the civil servant (a very different fellow to the money-saving bureaucrat) on public administration in terms of action. The dividing line will no longer be drawn between capital (partly wealth, partly money) and income, but between wealth (real things) and money.†

It is certain that we shall never get very far by tinkering our way along with Acts of Parliament, post-war credits, and other types of legal formulæ. It is true, of course, that a static legal foundation must exist, but it must be simple—a framework in general terms. Success in financial operations must depend to a large degree on freedom of action being granted to the qualified technicians. What, therefore, *is* needed in finance—above all else—is operatives with the right attitude of mind and the proper training. Tuition and research might profitably be directed towards creating the right type of financial technician, rather than producing a spate of schemes, plans, blue prints, &c.

Man and Movement

The broad conclusion to be reached is that our approach to finance, instead of remaining three-dimensional and impersonal, must become four-dimensional and more man-minded.

Incidentally, that way of thinking allows a clearer sense of perspective in the approach to many a topical problem. The vexed question of nationalisation is a case in point. It is gradually dawning upon people that what really matters is not the way things are owned, but the way things are run. Ownership—whether private or public—is a static and passive affair, the intrinsic importance of which is usually overrated. The Royal Air Force, for instance, is nationalised—and rightly so, from a functional viewpoint—but it is apparent to everyone that its success truly depends on the fibre and technical skill of the pilots and other personnel, and on the

* THE ENGINEER, September 12th, 1941.

† It may be said, without developing the statement in his article, that the commercial application of this revised principle would revolutionise—*inter alia*—our present accounting technique.

performance of the machines. Here again, by the way, we meet this same theme, "man and movement," the basic operating principle common to all forms of purposeful activity.

In stressing certain wider implications of this polytechnic evolution, I have endeavoured to make it clear that the financial engineer of to-morrow must not be conceived in isolation. Rather must he be imagined in relationship to a movement which is springing up in the arts, industries and professions, a movement which, in the words of Dr. V. A. Demant,‡ "signifies an attempt on the part of professional men to inquire into the real human and physical significance of their activity, to see its purpose in, as it were, the scheme of the universe."

Cement Plant for Shasta Dam

THE construction of the Shasta dam at Redding (Calif.) called for 6,000,000 bbl. of low-heat Portland cement, a quantity sufficient to keep a mill continuously active for a number of years.

Contractors are generally situated near the building site, but the Permanente Corporation had neither quarry nor plant in the vicinity. Previously it had explored certain raw materials near Permanente Creek, which is about 12 miles due west of San Jose (Calif.) and near enough to the dam. Suitable deposits of limestone and clay were found, and it was decided to build a mill and to develop the site. Having procured the cement contract, the Corporation was given no more than eight months to build and start deliveries of cement. Within this very short space of time the Corporation had to design and construct a mill, install the machinery, most of which had to come from the east, and get itself ready for shipment at a specified daily rate. This task was accomplished under the direction of Harry P. Davis, and deliveries started promptly at the time required by the contract.

The rock is excavated by the open strip mining process. An electric shovel which is fitted with a 5 cubic yard bucket and is equipped with a D.C. adjustable voltage system of control is used. The quarried rock is conveyed through an intricate system of semi-portable and fixed hoppers and conveyors to a jaw crusher at the quarry. There is a three-section belt conveyor, 36in. wide and nearly a mile long, for carrying the crushed rock to storage piles located near the mill. This three-section conveyor travels at a speed of 500ft. per minute and its capacity for all three sections is 1000 tons per hour. Each of the sections is operated by a 200 H.P. wound rotor induction motor equipped with a thrust or holding brake and magnetic control. The motor at each section is geared to the pulley at the uphill end of the conveyor. The weight of the rock load operating over the downhill sections produces an overhauling effect on the induction motors. These operate as induction generators, continuously controlling and braking the conveyor movement. It is estimated that about 300 kW of electric power is generated by the three main conveyor motors. This energy is absorbed by the mill and quarry distribution system and is equal to the energy needed to operate the 5 cubic yard shovel at the quarry. Thus the movement of the rock to the mill furnishes enough energy to excavate additional rock and to continue the main conveyor rock movement.

From the main conveyor, after travelling through a screen and short secondary conveyor, the rock is discharged on to an outdoor pile situated inside a small ravine with an estimated capacity of 550,000 tons, or 11,000,000 cubic feet, of cement rock. From the storage pile the rock is carried by other conveyors through various screens to cone crushers. Here the rock is reduced to various dimensions according to its different uses. These secondary crushers have a separate position outside the main building. The crushed rock is then carried to a storage bin, which is situated next to the main grinding mill.

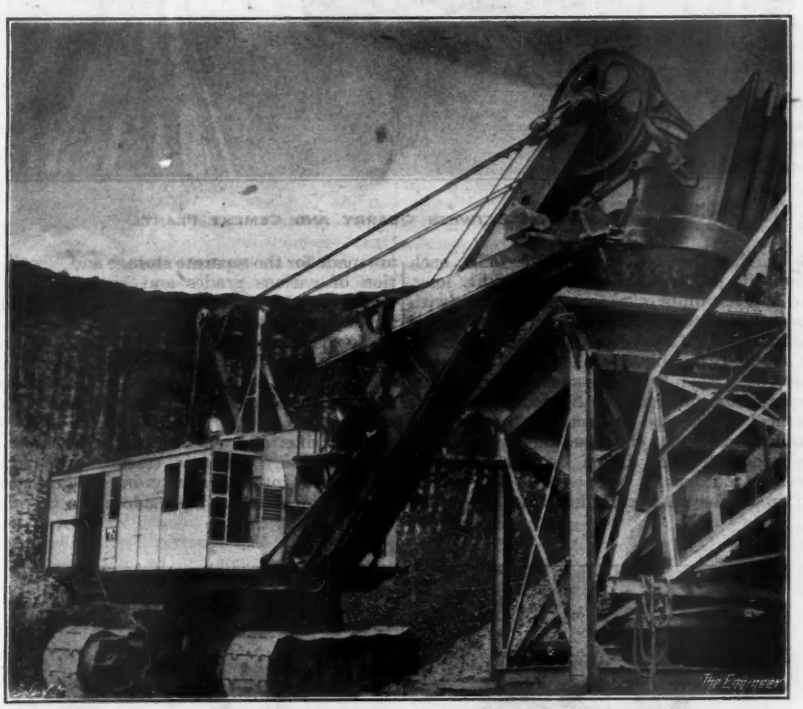
The building containing the main grinding mill has been designed to obviate unnecessary handling; it is compact and its arrangement assists operating supervision. There are major units for both raw and finish grinding, which are housed in one large building, 280ft. long, 132ft. wide and 75ft. high to the eaves. Inside this one building twelve large ball and tube mills operate, as well as four classifiers and three power-driven air compressors. Three kilns are closely adjacent to this mill at a somewhat higher elevation. From the storage bins (there are two, holding 8000 cubic feet each) the dry crushed rock passes through automatic weighing machines and is then fed to the primary ball mills, which operate in conjunction with classifiers. Each of these mills is driven by a full-voltage-started high starting torque, 500 H.P., 180 r.p.m., 2300-volt, three-phase, 60-cycle, synchronous motor, which is directly coupled to the mill pinion without magnetic clutch.

The output of the primary mills consists of slurry, which is pumped to another set of grinding mills which also operate in conjunction with classifiers. Each of these two secondary ball mills is driven by motors identical to those driving the primary mills and operate in the same way.

From the secondary mills the material moves in different ways depending on the type of cement being manufactured. Ultimately it is pumped into two large thickener tanks, which are 150ft. in diameter. The slurry is then carried to blending tanks, where it is mixed with ground wet clay. This clay is pumped separately into the blending tanks after having first been pulverised and then ground by two tube mills. Clay is stored in tanks 80ft. in diameter. The clay grinding tube mills are driven by motors identical with the others, so the mill possesses in its raw grinding department a total of six 500 H.P. high torque synchronous mill motors. After blending the slurry is pumped into special tanks, 80ft. in diameter, to await burning in the kilns.

There are three 3500-bbl. kilns, 12ft. in diameter. One of these kilns is 450ft. long and the two others 464ft. long each. Each kiln has seven riding rings and weighs about 1,500,000 lb. The slurry fed into the upper end of the kilns is dried by contact with hot gases, and in passing through the kiln to the lower firing end its temperature increases.

The clinkering or burning of the slurry is the next process, and in the case of the 450ft. kiln takes place at a lower elevation and is thence carried to a rotary cooler. In the other two kilns small chambers fastened to the outside of the firing ends of the kilns provide the cooling effect. The clinker must pass through these chambers to be cooled. Natural gas is used as fuel and is fed into the kilns through a single pipe inserted in the centre of the kiln at the firing end. For combustion air is fed into the kiln adjacent to the gas burners. There is also a large draught fan attached to the feed end of each kiln for drawing the combustion gases through. Elaborate control panels which operate the kilns are situated at the firing ends. At the control stations combustion air is regulated through the movement of various dampers, the quantity of fuel burned is also regulated and the rotation speed of the kilns adjusted. Maximum speed of each kiln is 1 r.p.m., but this can be reduced to about one-third of that speed by remote control. To conform to the speed at which the kilns rotate the speed of the kiln feeding mechanism is automatically adjusted by means of an electrically connected synchronous drive arrangement.



FIVE CUBIC YARD ELECTRIC SHOVEL

The last kiln to be installed is of special interest. It is driven by a 200 H.P., 440-volt, three-phase, 60-cycle, adjustable speed motor, providing a speed adjustment range of three to one. Its control provides for speed adjustment, start, stopping and, like the other kilns, is regulated from the control panel situated at the burning end of the kiln. Its motor is situated near the centre and is connected to the kiln gearing through a reduction gear. This is said to be the largest A.C. brush shifting

‡ In a letter to *The Accountant*, June 6th, 1942.

adjustable speed motor driving a cement kiln operating in the United States. The large fan at the feed end of this kiln is driven by a 150 H.P., 550-volt, three-phase, 60-cycle, squirrel-cage induction motor, which is provided with an extended shaft, outboard bearing, base and rails for connection to the fan through a silent chain drive.

The cooled clinker passes to the clinker storage in the finish mill bins, where it is ready for the finish grinding. From these bins to the finish mills the clinker moves through automatic continuous weighing machines. The finish fine grinding is done in four tube mills, each about 8ft. in diameter and about 40ft. long. Two of these units operate in conjunction with smaller separately driven ball mill units, called preliminators. Each of the tube mills is driven by a 100 H.P., 180 r.p.m., 2300-volt, three-phase, 60-cycle, full-voltage-started, high-torque synchronous mill motor. All four motors are identical and all are connected to mill pinions without magnetic clutches. The two preliminators are each driven by 500 H.P. synchronous motors.

Two of the tube mills have air separators installed above the mills. Each of these separators is driven by a 40 H.P., 440-volt, three-phase, 60-cycle, brush-shifting, adjustable-speed A.C. motor, providing a speed range with a ratio of three to one. The motors are connected to the separators by a V belt and are provided with a pilot motor mechanism for remote electrical speed adjustment.

Finally, the finished cement is conveyed by pumps to storage silos. There are twenty-seven silos and sixteen store bins with a total storage capacity of 500,000 bbl., or forty days' production of finished cement. Arrangements are made for the separate storage and identification of various grades and kinds of cement which may be manufactured at different times for different purposes.

The pack house and bag house are adjacent to the storage silos; thus, facilities are available for packaging before shipment, when required, or shipment of bulk cement drawn directly from storage.

Both silos and pack house are served by standard-gauge railway tracks, over which trains run into a railway interchange yard, where cement trains are made up to be pulled to Shasta dam. Arrangements also exist for the ready loading of finished packaged cement for shipment by lorry.

The rated output of the plant based on burning capacity is 10,500 bbl. of cement per day. To ship cement from the plant by rail at a rate corresponding to this capacity requires the movement of thirty-five standard fully loaded 300-bbl. cement cars from the plant each twenty-four hours.

BELT CONVEYOR BETWEEN QUARRY AND CEMENT PLANT

THE THREE ROTARY KILNS

Institute of British Foundrymen

AT the annual general meeting of the Institute of British Foundrymen, held in London on Saturday, June 20th, 1942, Major R. Miles, M.Eng., was unanimously re-elected President for 1942–43. Major Miles is managing director of Head, Wrightson and Co., Ltd., Thornaby-on-Tees. Mr. D. H. Wood, of the Constructional Engineering Company, Ltd., Birmingham, was re-elected Senior Vice-President for 1942–43, and Mr. D. Sharpe, managing director of Walter MacFarlane and Co., Ltd., Saracen Foundry, Glasgow, was elected Junior Vice-President for 1942–43.

Following the annual meeting, the E. J. Fox Gold Medal, 1942, was awarded to Mr. P. H. Wilson, assistant managing director (technical) of the Stanton Ironworks Company, Ltd., for his work in the development of the centrifugal casting process for the production of cast iron pipe. The presentation to Mr. Wilson was made by Mr. E. J. Fox, who is about to retire from the managing directorship of the Stanton Ironworks Company, Ltd.

The Oliver Stubbs Gold Medal for 1942 was awarded to Mr. S. H. Russell, Past-President and Honorary Treasurer, in acknowledgment of the educational work which he has undertaken for many years as Chairman of the City and Guilds of London Institute Advisory Committee; the contributions which he has made to the discussions on papers at branch meetings; his work as Honorary Treasurer of the Institute; and his Chairmanship of the Organisation Committee responsible for drafting the proposed new rules. Mr. S. H. Russell is managing director of S. Russell and Sons, Ltd., Leicester.

The Meritorious Services Medal for 1942 was awarded to Mr. S. W. Wise in recognition of the considerable service which he has rendered to the Institute during thirty years of membership. Mr. Wise has been Registrar of the Newcastle Branch and a Vice-President of that Branch; he was an examiner for the John Surtees Memorial Examinations, and for the past sixteen years has been Honorary Secretary of the West Riding of Yorkshire Branch.

The Fifth Edward Williams' Lecture, entitled "Foundry Team Work," which had been prepared by Dr. H. W. Gillett, editorial director of *Metals and Alloys* and chief technical adviser to the Battelle Memorial Institute, Columbus, Ohio, U.S.A., was presented on behalf of the author by Mr. J. G. Pearce, M.Sc., M.I. Mech. E., M.I.E.E., F. Inst. P., Director of the British Cast Iron Research Association.

After the presentation of the lecture, a luncheon was held and in the afternoon the following papers were presented and discussed: "The Production of Uniform Steel for a Light Castings Foundry," by C. H. Kain and L. W. Sanders; "Arma Steel: Its Manufacture, Control, and Applications," by Carl F. Joseph; "The Substituting of High-duty Grey Iron for Steel Castings," by J. Blakiston, A.I. Mech. E.; Reports on Low-tin and Tin-free Bronzes and Brasses by the Non-ferrous Sub-Committee of the Institute's Technical Committee.

TO WATCH FUEL CONSUMPTION.—A body, which is likely to be followed by others, has been set up under the name of the North Wales Fuel Efficiency Committee. It has been charged with the responsibility of ensuring that fuel is used efficiently by industrial undertakings throughout the six North Wales counties. Every works in the area making use of coal will have its fuel-using equipment, together with its steam utilisation methods, carefully investigated. To facilitate the work, a series of specialised panels of engineers has been appointed and the various industries have been grouped.

Two-Stroke Two-Shaft Opposed-Piston Oil Engine

IN the *Sulzer Technical Review* of December 31st, 1941, which has just reached us, an interesting account is given of the firm's recent experiments in the supercharging of two-stroke oil engines and some new types of engines which have been designed and built as a result of these experiments. As early as 1912 the Sulzer principle of extra-charging was introduced, by which, after the normal process of scavenging was finished, the cylinder was slightly supercharged to the pressure of the scavenging air by admitting further air through an upper series of ports. In special cases, such as peak load and emergency plants, the degree of extra-charging was increased during the overload periods. By such means the extra-charging pressure was raised to about 1·2 to 1·4 atmospheres, giving an increase in output of from 10 to 30 per cent., compared with an engine working without extra-charging.

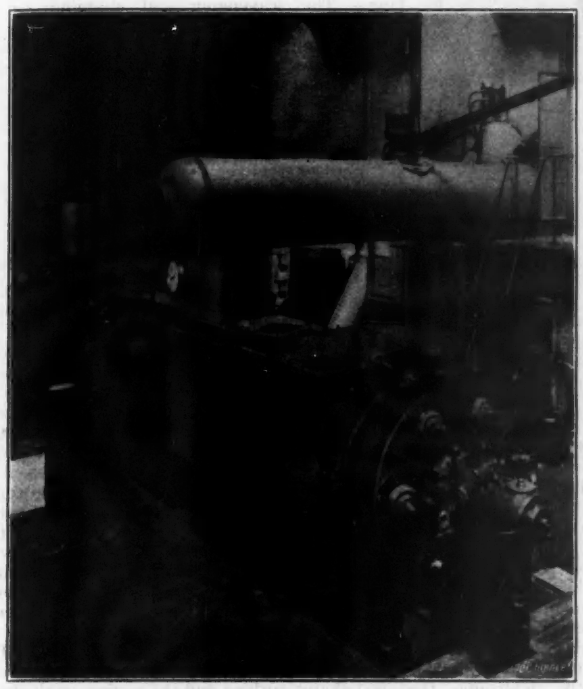


FIG. 1—EXPERIMENTAL FREE-PISTON POWER GAS GENERATOR

EXPERIMENTAL WORK

Further experiments which were carried out with engines of the two-stroke type showed that supercharging can be carried up to 5 or 6 atmospheres and effectively used, with a reciprocating scavenging air pump or a rotary air compressor, which can be driven either from the engine shaft or by an exhaust gas turbine. In the case of high supercharging a degree can be reached where the power delivered by the oil engine and the power absorbed by the supecharging compressor become equal. In such an installation the turbine may be uncoupled from the oil engine and from the compressor without the energy of the whole system being thereby disturbed, the effective output of the whole plant thus corresponding to the output of the exhaust turbine. In such a plant the unit, composed of the oil engine and the compressor, serves exclusively to supply exhaust or "power gas" and no longer delivers any mechanical energy, that task devolving on the exhaust turbine. This type of plant has been designated as a power gas generator, and such plants have been the object of study and research in the Sulzer works for possible uses as traction units and special ship propulsion installations. Alongside the oil engine and compressor and the separate exhaust turbine, the power gas generating process can be effectively worked with free-piston power gas generating plant, in which each of the opposed pistons of an oil engine is coupled direct to an air compressor piston, which compresses the scavenging and charging air, no crankshaft being needed, as the pistons are simply linked together in a manner to ensure their running symmetrically. In Fig. 1 we show a Sulzer experimental free-piston power gas generator on the test bed at Winterthur.

The subdivision of two-stroke supercharging may be conveniently summarised in accordance with the following table :—

Supercharging pressures (abs.).	Process.	Characteristics.
1·0 to 1·7 atm. (14 lb. to 24 lb. per sq. inch	Extra-charging	Supercharging without exhaust gas turbine
1·5 to 1·7 atm. (20 lb. to 24 lb. per sq. inch)	High supercharging	Supercharging with a reciprocating pump and with an exhaust gas turbine coupled to the engine. Supercharging with a coupled charging set
5 atm. (70 lb. per sq. inch) and more	Power gas process	Supercharging with independent exhaust turbine and possibly with a precompressor

Based on the experimental work and studies we have referred to and on the theoretical investigations of the remaining thermodynamic problems, also taking into consideration the manufacturing processes and constructional elements and economic considerations such as price, weight, and space required, Sulzer Brothers several years ago took up the process of two-stroke high supercharging to which we have referred in the above table.

The first work was to design and build an experimental engine in order to check the relations, which had been theoretically determined, by further running tests. The first tests to be made were confined to the oil engine alone, the influence of the exhaust gas turbine being imitated by using a throttle orifice. Air needed for the scavenging and charging was taken from the compressed air system in the shops, and was heated up to the temperature corresponding to the polytropic compression of the normal air compressor. The power was measured by means of an hydraulic brake. With this experimental engine, supercharged to 2 atmospheres absolute, a mean effective pressure of 12 kilos. per square centimetre was attained with an absolutely clear exhaust. It was further found that this effective pressure could be maintained for a considerable length of time without any difficulty. This refers to the engine alone, without considering the work done by the turbine and the power absorbed by the air compressor, which, as already mentioned, approximately balanced one another. During a special test, which was undertaken later on another engine with the same supercharging pressure, a mean effective pressure of as high as 13 kilos. per square centimetre was maintained for forty-eight hours. The engraving we reproduce in Fig. 7 shows the excellent state of the piston

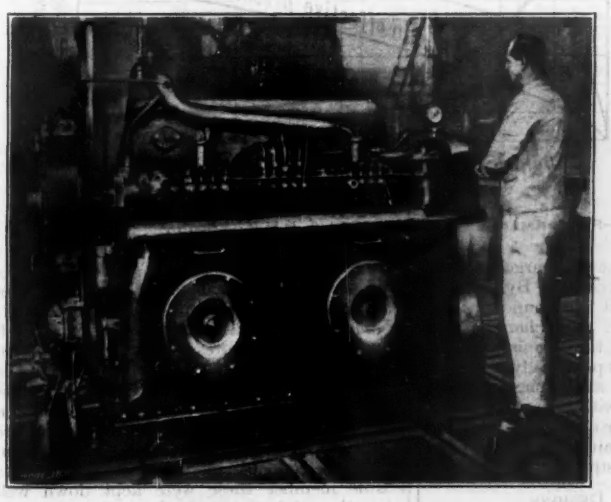


FIG. 2—1370 B.H.P. SUPERCHARGED TWO-STROKE OIL ENGINE

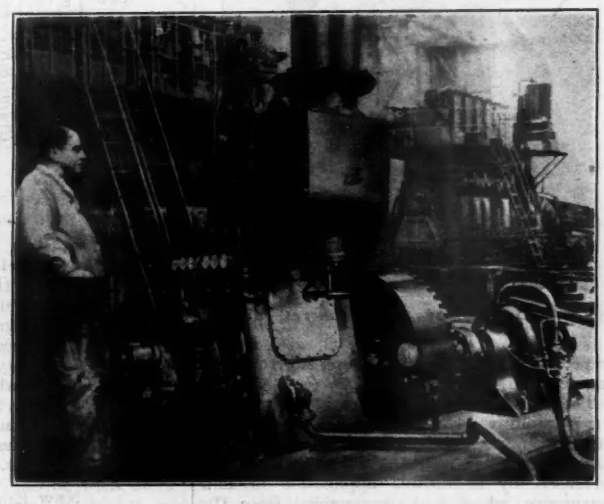


FIG. 3—692 B.H.P. SUPERCHARGED SINGLE-CYLINDER ENGINE

after the conclusion of the test. It may be noted that in comparison with a non-supercharged two-stroke engine, the increase in output or mean effective pressure was 100 per cent. It will be clear that an increase of this order of magnitude could only be obtained after all the constructional elements of the engine had been suitably adapted, both with regard to material and design, to comply with the increased stresses. It was, of course, stipulated from the beginning that the reliability of the highly supercharged engine should be in every respect equal to that of the non-supercharged engine.

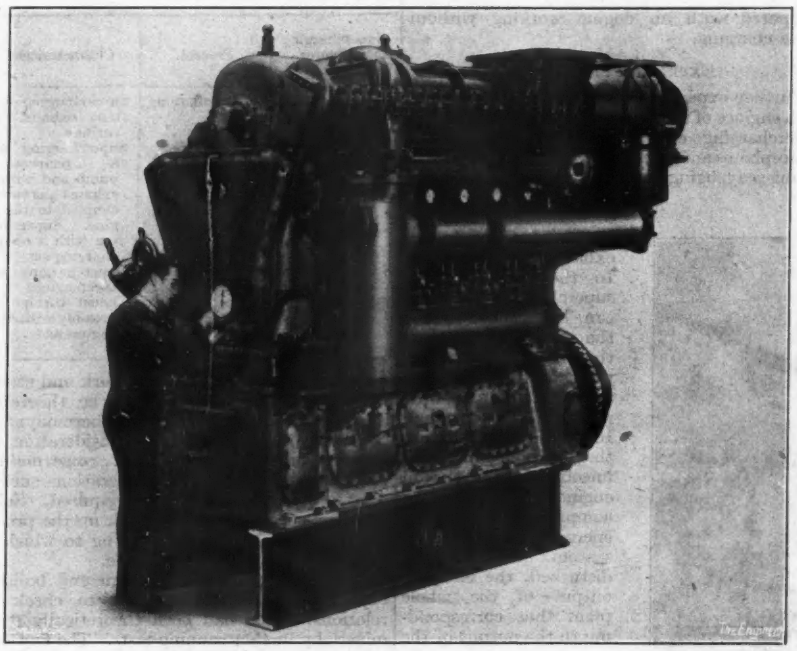


FIG. 4—1560 B.H.P. TWO-SHAFT OPPOSED-PISTON ENGINE

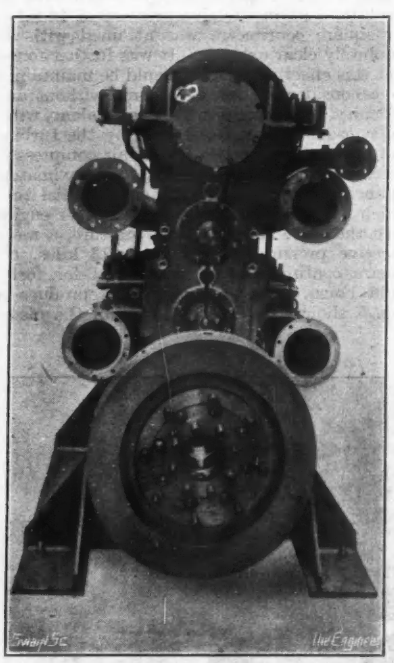


FIG. 5—END VIEW OF EXPERIMENTAL ENGINE

These favourable results clearly showed that the possibilities of two-stroke high supercharging were by no means exhausted, and that the supercharging pressure could be still further increased by a suitable application of new experience, which had been gained from the experiments.

The experimental engine already referred to was again run with a supercharging pressure of 3 atmospheres absolute, which allowed a mean effective pressure of 15 kilos. per square centimetre to be maintained as long as desirable, with a perfectly clear exhaust. It was found that it was even possible to increase temporarily the mean effective pressure still further without the exhaust becoming visible.

With high supercharging it was shown that the attainable mean effective pressure was not limited by the visibility of the exhaust—that is, by the combustion—the conditions of which had been improved by increasing the clearance space, but by the permissible heat stresses in the surfaces exposed to the combustion process. These stresses consequently determine the admissible quantity of heat introduced into the combustion process—that is, the degree of saturation of the fuel in the air charge—and, in turn, the mean effective pressure. By reducing the degree of saturation it was found possible to increase the degree of supercharging still further without exceeding the permissible heat load. This possibility was practically tested on the same engine, which, after increasing the clearance space, was run with degrees of supercharge increasing gradually up to 6 atmospheres absolute, raising the mean effective pressure gradually to 18 kilos. per square centimetre.

NEW ENGINE DESIGNS

Based on the excellent results which were obtained with the engine above referred to, the construction of a new engine supercharged up to 2 atmospheres absolute was put in hand, the design corresponding to the requirements which are generally met with in traction schemes, but having in mind other uses, such as peak load, standby, and emergency electric supply services. As the aim of the design was to obtain an engine with as high an output density as possible, an opposed-piston arrangement of cylinders was adopted. A view of the unit is reproduced in Fig. 2. In order to suit the space for which it was intended, four horizontally arranged cylinders were used, each of which was fitted with two diametrically opposed injection nozzles. The exhaust gas turbine was overhung and was coupled direct to the exhaust manifold. The output of the engine is transmitted to the crankshaft through spur gearing. The scavenging and charging air is supplied by a reciprocating air compressor direct coupled to the engine crankshaft.

The principal dimensions of the new engine are given in the following table :—

Number of cylinders	Four
Cylinder bore	190 mm.
Piston stroke	2 × 300 mm.
Running speed	750 r.p.m.
Piston speed	7·5 m. per sec.
Designed output (one-hour rating)	1370 B.H.P.
Mean effective pressure at one hour rating, including turbine and compressor... ...	12 kilos. per sq. cm.
Fuel consumption...	158 grammes, or 0·35 lb., per B.H.P.-hour

The curves given in Fig. 6 show the fuel consumption, speed, charging pressure, and mean effective pressure of the engine as a function of the load, when working according to the propeller law. For the sake of simplicity, the exhaust gas turbine was built as a single-stage machine, but by adopting several stages, it is pointed out, the efficiency of the turbine could be increased, thereby improving still further the fuel consumption and the output of the whole set. The engine we have described was tested out in industrial service in the Sulzer works for over 1000 hours, and it was shown that the newly designed constructional elements were able without difficulty to comply with all the conditions which were stipulated. The mechanical transmission of the energy between the exhaust turbine and the engine crank shaft, never gave rise to any trouble, while even in periods of severe cold the engine started easily.

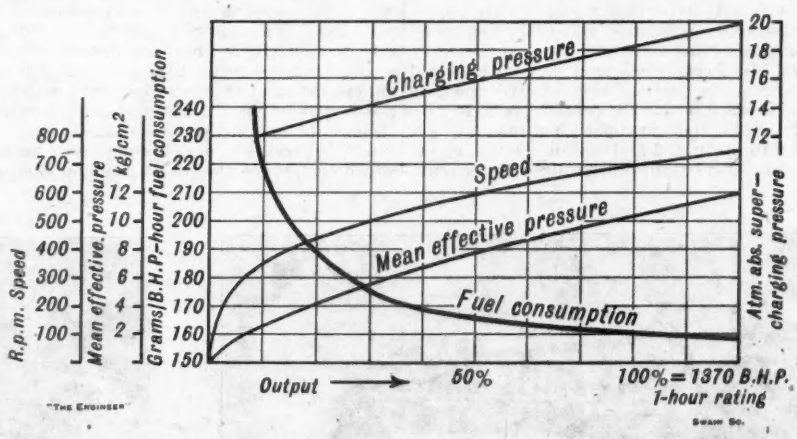


FIG. 6—PERFORMANCE CURVES OF 1370 B.H.P. ENGINE

This new Sulzer engine, it is claimed, represents the first practically usable realisation of a two-stroke supercharged engine with a built-in exhaust gas turbine, enabling such high mean effective pressures to be attained. With regard to design, it is pointed out that the coupling of the engine crankshaft to the exhaust turbine, which runs at a speed of about fifteen times as fast, involved the use of particular care in order to prevent possible trouble arising from critical speeds. By inserting an intermediate flexible member these were kept down well below the minimum no-load speed, so that no critical speeds had to be run through in normal

operation. In addition, a slip coupling, designed in such a manner that it could slip only when a certain maximum torque was exceeded, was fitted as a vibration damper. Practical service with these devices showed, we understand, that the oscillation problems arising from this particular mechanical transmission can be completely solved by the device adopted. It is possible that in some instances the flexible member and slip coupling may be conveniently replaced by an electro-magnetic or hydraulic coupling, or some form of electric drive may be chosen. The mechanical coupling was, however, chosen as giving the best efficiency, and therefore the lowest fuel consumption.

In order to test the suitability of high-pressure supercharging in the region of 2 to 6 atmospheres absolute, with high-speed working, a further experimental engine—see Fig. 5—was built, having cylinders with a bore of 120 mm. and 150 mm. stroke, and intended to run at first at a speed of 1500 r.p.m. In spite of the unusually high speed, this new design of engine easily reached the mean effective pressures attained with the former experimental engines. These were 12 kilos., 15 kilos., and 18 kilos. per square centimetre when supercharged to 2, 3, and 6 atmospheres absolute respectively, the fuel consumption range varying from 180 to 190 grammes per B.H.P.-hour at a speed of 1500 r.p.m. These figures hold good for the engine alone, and the output of the turbine and the power absorbed by the air compressor are not considered, for, as previously mentioned, they practically balance each other. In later tests with the same engine the speed was raised to 2400 r.p.m., which corresponds to a piston speed of 12 m. per second.

Other tests were carried out on a single-cylinder, single-piston engine, having a bore of 420 mm. and a stroke of 500 mm., which when supercharged to 2 atmospheres absolute developed 692 B.H.P. at 450 r.p.m., with a mean effective pressure of 10 kilos. per square centimetre. This experiment showed that the output increases up to this limit in practically direct proportion to the degree of supercharging, thus confirming the results that had been obtained with engines of smaller cylinder bore in the same field. In this connection it may be stated that in single-piston engines of large cylinder bore, scavenging can be effected as perfectly as in normal engines, provided that suitable measures are taken. The adoption of high supercharging for such engines must, of course, take into consideration details of design, which demand that in all sizes and types of engine the design is suited to the higher ignition pressures adopted and the resulting higher heat stresses.

NEW DESIGN OF TWO-STROKE, TWO-SHAFT ENGINE

The extension of high supercharging to two-stroke engines of new design was shown to be both adaptable and effective, and it seems as if a wide range of new possibilities are opened for this new prime mover. It is likely that, on the one hand, there will be a reduction in price, weight, and the amount of space required for a unit of given output, while, on the other hand, the output range will be extended and the fields of useful application widened. In recognition of this new development and its implications,

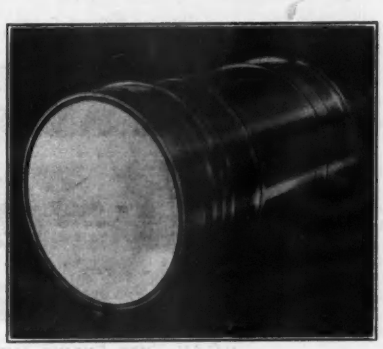


FIG. 7—PISTON AFTER 48-HOUR OVERLOAD TEST

the firm of Sulzer Brothers, of Winterthur, has gradually started to modify the designs of its single-piston engines of medium-sized and large-bore cylinders to suit the new requirements of two-stroke supercharging. Simultaneously with this work, the company has designed a new type of oil engine—see Fig. 4—which has allowed a far-reaching utilisation of the possibilities offered by the high supercharging process, which was worked out on the experimental engines to which we have already referred. The new type of engine is of the two-shaft, opposed-piston type, with the following principal dimensions :—

Number of cylinders	Six
Bore of cylinders	180 mm.
Piston stroke...	2 × 225 mm.
Piston speed	6·375 m. per sec.
Running speed	850 r.p.m.
Supercharging pressure ...	2 atm. abs.
Designed output, one-hour rating	1560 B.H.P.

The engine is built in such a way that it can be supercharged experimentally with 6 atmospheres absolute, thus raising its output to 2340 B.H.P., and further reducing its specific weight. By removing the two exhaust gas turbines it can also be used as a power gas generator unit. In that case its output would be limited to supplying, alone or with other units, the power gas required for driving an exhaust gas turbine. In the drawing—Fig. 8—we show the general outlines of a similar eight-cylinder engine, which has a designed one-hourly rating of 2750 B.H.P. when running at 1000 r.p.m. and supercharged to 2·5 atmospheres absolute.

The introduction of the supercharged two-stroke oil engine into practical service will, the makers state, as in the case of other novel designs, only take place gradually. Drawings, however, reproduced in the *Review* show clearly the applications of such engines for electric power stations, marine propulsion, and other purposes.

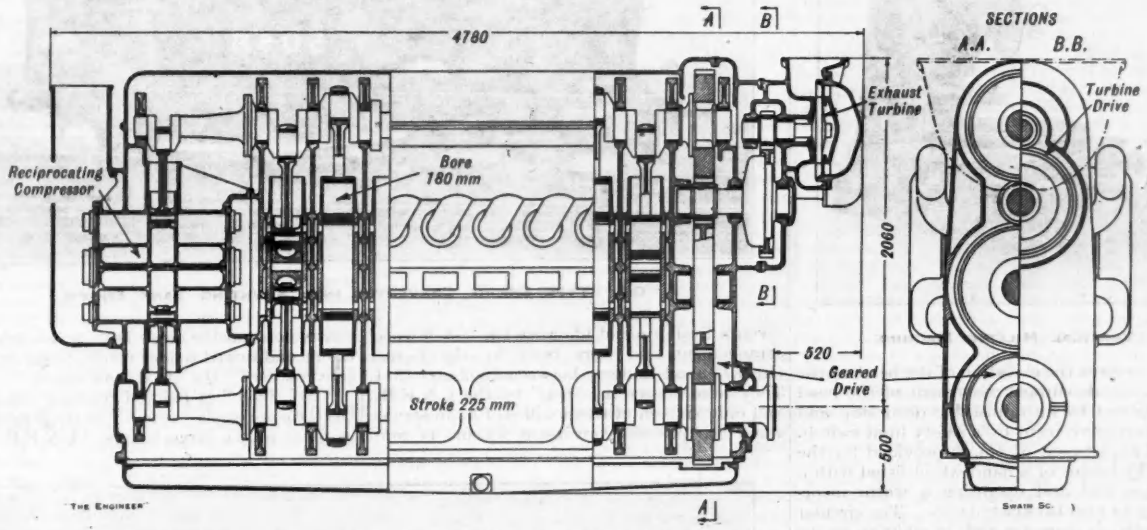


FIG. 8—SECTIONS OF EIGHT-CYLINDER 2750 B.H.P. TWO-SHAFT OPPOSED-PISTON ENGINE

The "Glo-Pass" System

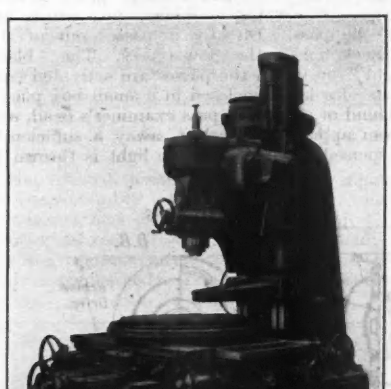
THE difficulty of inspecting many passes at night, without holding up the entry or exit of workers, is a problem that has been overcome by using the "Glo-Pass" system, invented by Colloidal Research Laboratories, Ltd., 66–70, Petty France, London, S.W.1. By means of this system it is claimed to be possible to ensure completely against any unauthorised person gaining access to a building by means of a forged pass. The system simply entails the coating of a pass with transparent lacquer. This lacquer is invisible in ordinary light, but when the pass is brought under a "black light," whatever may be on the pass shows up brilliantly. The lacquer, being transparent, does not obscure print, photographs, signatures, numbers, &c., which are on the pass. Directly it passes out of the "black light" the glow ceases. The "black light" by which the passes are activated consists of a lamp enclosed in a small box placed behind or above the pass examiner's head, and from approximately 10ft. away a sufficiently dispersed beam of invisible light is thrown to allow a double file of employees to be indentified simultaneously. Close scrutiny of individual passes is unnecessary; any difference in the glow is detected immediately. The lacquer used is a special transparent fluorescent liquid which dries immediately on application. Immediately it is placed under the "black light" it attains its maximum brilliance, but on passing out of the beam it is extinguished at once. This characteristic differentiates it from substitute materials that might be used, such as the sulphides, on faked passes or badges. With them there is always a distinct afterglow. This is one speedy way of detecting a forged pass. Furthermore, the lacquer, when it comes under the "black light," gives a peculiar and characteristic tinge in its glowing, which, it is claimed, is extremely difficult, if not impossible, to imitate.

The lacquer is supplied ready for immediate application. It should be gently rubbed into

the face of the pass or badge with a clean rag. As it is quick-drying, there is no difficulty in treating many hundreds of passes, &c., in a short space of time. For purposes of security the lacquer supply should be kept in a special place, where it cannot be tampered with. Furthermore, only the minimum of personnel, and those occupying responsible positions, should be allowed access to it and the use of it. Colloidal Research Laboratories, Ltd., are also prepared to arrange for the special treatment of passes, &c., for their clients, whenever it may be required. In such special circumstances the lacquer will be of a different and distinctive colour and will not be allowed out of the company's laboratories. A range of different colours is available.

A Large Vertical Milling Machine

WE illustrate herewith the latest design of the largest model of vertical milling machine—known as the C.V.M. 65—made by Kendal and Gent, Ltd., of Gorton, Manchester. The machine is equipped with three motors, a driving motor of 20 H.P. mounted vertically on the spindle head, a reversing feed motor of 3 H.P., and a reversing head elevating motor, also of 3 H.P. The spindle has a speed range of from 10 to 284 r.p.m., and there are eight rotary feeds varying from ½in. to 6½in. per minute, as measured at the mean diameter of the table. A push button



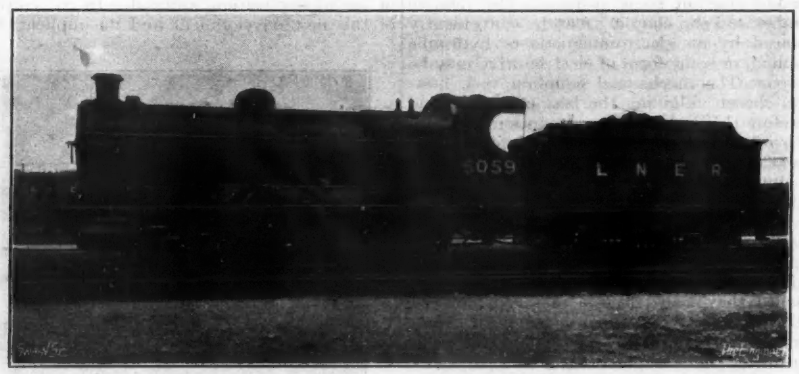
VERTICAL MILLING MACHINE

control governs the elevation of the head on the column, the downward movement of the head being limited by an adjustable dead stop and the upward movement by a safety limit switch. A hand adjustment of 6in. is provided for the spindle by means of a hand wheel fitted with a graduated dial and operating a worm incorporating an anti-backlash device. The circular table is 4ft. in diameter and, in addition to the circular feeds, can be given a longitudinal traverse of 5ft. and a transverse traverse of 2ft. 9in. Considerable use has been made of densified iron at various points in the machine, notably for the sliding surfaces of the major castings and for the spindle sleeve. The spindle itself is of heat-treated high-tensile steel and the gear wheels are of nickel-chrome steel. All the electrical gear is built into the column and includes an automatic cut-out connected to the inspection door.

L.N.E.R. Locomotive Conversions

To produce with the minimum of delay shunting engines urgently needed for wartime freight traffic, the L.N.E.R. is converting into tank engines for heavy shunting duties twenty-five of its older type eight-coupled freight tender locomotives, which, but for the war, would have been scrapped. By thus avoiding the construction of new shunting engines 900 tons of steel will be saved, and as no new steel castings have been required, no demands have had to be made on steel foundry capacity.

Furthermore, the tenders made available by the conversion will be allocated to new 2–8–0 coal traffic locomotives now under construction at Doncaster, with the result that it will be possible to place these engines more quickly in service. The work of conversion is, in fact, taking place side by side with the construction of the new 2–8–0 engines.



"Q4" TYPE ENGINE AND TENDER BEFORE CONVERSION

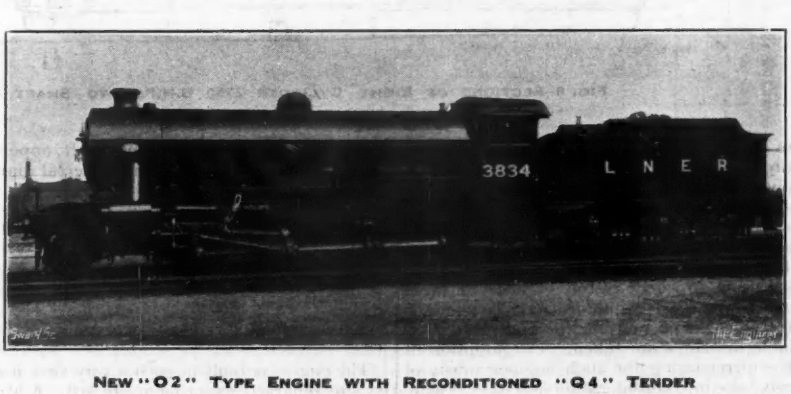
The locomotives that are being altered and given a fresh lease of life have the 0–8–0 wheel arrangement and were built by the former Great Central Railway between 1902 and 1911. They were classed as "Q4" by the L.N.E.R., and only sixteen of them will still be in service when the present conversion scheme is completed. As tank engines, reclassified as "Q1," they will retain the 0–8–0 wheel arrangement. The side tanks hold 1500 gallons of water and the bunker 4½ tons of coal, and the total weight of each engine in working order is 69 tons 18 cwt. The framing at the back end has been built up to take the tank engine type of buffer and draw gear arrangement, but apart from these alterations the whole of the old material has been worked in. With a tractive effort of 25,644 lb. they are considerably more powerful than the standard L.N.E.R. six-coupled shunting engine and they will therefore be used for the heaviest shunting duties. These engines will be the first 0–8–0T built by the L.N.E.R. At one time the company had a single 0–8–0T engine, but it was withdrawn in the first year of grouping. It was "No. 400B" of the Great Central.

Our illustrations show "Q4" before and after

"Q4" TYPE ENGINE CONVERTED INTO SHUNTING TANK ENGINE

conversion and the new "O2" type engine with the reconditioned tender made available by the conversion of "Q4" to a tank engine.

"No. 5058" is painted wartime black, and has the company's "totem" on the bunker sides in place of the large letters "L.N.E.R." that have hitherto been displayed. She is already in service and was on inspection at Liverpool Street on June 15th.



NEW "O2" TYPE ENGINE WITH RECONDITIONED "Q4" TENDER

The work of the conversion of these engines has been carried out at Doncaster to the designs of Mr. E. Thompson, Chief Mechanical Engineer of the L.N.E.R.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Cinder and Scale Prices

The Minister of Supply has issued the Control of Iron and Steel (No. 22) Order, 1942, which amends the price schedule of the No. 15 Order in so far as cinder and scale for use in blast-furnaces and steel furnaces are concerned. The principal alteration is an increase in the prices of cinder and scale for use in steel furnaces. The advance in price from Order No. 15, which was issued on July 12th, 1941, is for good clean scale for use in open-hearth steel furnaces, f.o.t. producing works; Order No. 15, £1 4s.; Order No. 22, £1 10s. The latest Order includes the following:—Scale for use in blast-furnaces in Shropshire, £1 5s. 6d.; scale for use in any other blast-furnace or in sintering plants, £1 3s., compared with £1 5s. 6d. in Order No. 15; cinder for use in open-hearth steel furnaces, f.o.t. producing works, £1 10s. With the growth of the production of steel, both the quantity of scale arising as well as the demand has increased. The scale is the flakes which, during working, break off the surface of metal which has been heated, and arises in considerable quantities in rolling mills. The descriptions include roll scale and hammer scale. Cinder is the refuse or dross that comes from puddling furnaces, and is frequently called tap cinder. It consists mainly of protoxide of iron and siliceous matter. Formerly this tap cinder was used by blast-furnaces to mix with inferior ores, and remade into cinder pigs for cheap foundry work. Changes in practice, however, have resulted in tap cinder coming to be regarded as a valuable iron ore, and it is largely used in the manufacture of basic pig iron for the steel works. Owing to its greater value when used in this form, the making of cinder pig has largely disappeared; whilst in consequence of the decline in production of wrought iron in the years before the war, less tap cinder is available than formerly.

The Pig Iron Market

Rather quieter conditions have ruled in the pig iron market. This is largely because consumers have covered their allocations for Period III, and there is a tendency in the foundry trade to refrain from undertaking commitments until the results of the concentration scheme can be more clearly seen. As a result, it is probable that many of the foundries have been using stocks recently, rather than placing further orders. The situation in the foundry trade has not materially altered for a considerable time. The light castings industry is far from fully employed, and is not likely to be so until commercial building is resumed. Jobbing foundries are moderately engaged, particularly those which are engaged directly or indirectly on some form of war work, whilst the heavy foundries have as much work in hand as they can undertake in most cases. Supplies of pig iron are equitably distributed by the Control, but little or no hematite is now used by this section of the industry. Refined iron and low-phosphoric pig iron is being used in increasing quantities, and in some cases it has been found possible to use high-phosphoric pig iron as a substitute for one or other of these. Some tightness threatened to develop in the refined and low-phosphoric pig iron position, but any adverse consequences have been avoided by the careful distribution by the Control. Foundries are able to obtain good supplies of suitable scrap. In the basic pig iron market the situation is satisfactory, although at one time it was feared that there might be a stringency. The high rate of production of the British producers, coupled with stocks of imported pig iron, have enabled the steel works to have their requirements adequately filled. The Scottish pig iron industry is operating at a high rate of capacity, and the output passes into immediate consumption. The Scottish light foundry industry is only partially employed, and its requirements of high-phosphoric pig iron are comparatively small. On the other hand, there is a vigorous demand for low-phosphoric pig iron, and some of the Scottish brands of foundry iron which normally are used to a considerable extent by Lancashire textile machinery makers are becoming rather scarce. The tightness of the position, however, is only relative, and the Control, wherever possible, is encouraging the use of other pig irons as substitutes.

Midlands and South Wales

The extreme pressure from consumers to obtain supplies from the Midlands steel works has lasted so long that it has now become almost a normal condition. The production of all kinds of steel has been raised to a very high level, but the munitions and armaments drive has resulted in consumers' requirements expanding to an equal degree to the increased output. Little change has occurred in the incidence of business, and the departments experiencing the greatest pressure are those which have been subjected to a heavy demand for some months. The most noticeable feature of the situation is the large volume of business passing in ship and tank plates. Perhaps the heaviest thicknesses are mostly in demand, but there is an insistent call for medium plates, and in a growing number of cases the works are expanding the periods required for delivery. The measures taken by the Iron and Steel Control, however, appear to have overcome the problems of delivery, and firms engaged on Government work have little cause to complain of delays. Almost as strong as the demand for plates is the call for alloys and special steel. This material is used in ever-growing quantities by armaments and munition makers and in aircraft production. Large quantities are also used by the makers of mechanical equipment, although here and there some delay has occurred, principally because of the heavy orders in the hands of the producing works. Continual efforts are being made to increase outputs, and the production of these special steels is probably on a higher scale than at any time in the history of the industry. The activity in the iron trade is much less than in the steel section. Iron bars are required in smaller quantities than steel, and the demand is chiefly for small sizes. Most of the works, also, could deal with more orders for Crown bars, whilst there is not more than moderate business passing in iron strip. The South Wales iron and steel trades are producing on a heavy scale, and practically all the output is on Government account. The demand for structural steel is still rather weak, but the smaller sizes are in much better demand than the heavier sections. This reflects the situation at the works of the structural engineers. Few of them are employed to the full extent of their capacity. There is a large output of sheet and tinplate bars, although the demand for the latter has declined. The producing works, however, are finding a fresh market in the Midlands, which is being supplied with fairly large quantities of semis. The sheet works have good order books, but business now is almost entirely confined to black or painted sheets, and the special qualities required for Government work.

The North-East Coast and Yorkshire

The steel works on the North-East Coast have been working under considerable pressure during the past few weeks, to clear up the contracts in hand before the end of Period II. Consumers have now placed most of their allocations for Period III, and the works will pass from the second to the third period without any diminution in activity. There was little change in the conditions of the market. The most noticeable feature is the continued pressing demand for alloy and special steels and plates. Efforts are being made to increase the production of the latter description of steel, particularly of the heavier thicknesses, but the demand in this department is such that increases which have been made in production have been speedily overtaken by the increase in consumers' requirements. The boilermakers, shipyards, and tank-building firms are fully employed, and their requirements absorb practically the whole output of the plate mills. The alloy and special steel position is better than it was some weeks ago, but the demand is immediately taking up the production. The output of the British works has been considerably expanded in the past eighteen months, but the requirements of the armament makers, particularly the producers of mechanised equipment, have also increased, and therefore efforts are being made to economise in the use of alloy steels, as well as to increase the production. In other directions the incidence of the demand does not appear to have altered during the past week or two. Sheet makers have a fair amount of work on hand, largely on Government account. All their orders are for special descriptions, but there is a growing demand for black sheets and painted sheets, which are being used in increasing quantities now that galvanised sheets are practically unobtainable except for special Government requirements. The demand for structural steel of the small sizes is maintained, and the re-rollers are doing an active business, but there is a poor request for the heavier joists and sections. In Yorkshire the steel industry is fully employed upon essential work. Much consideration has been given to the problem of holidays, and it is hoped that a considerable proportion of the melting furnaces will be overhauled whilst the operatives are taking their holidays. At the same time, arrangements have been made so far as possible to avoid any interruption in production as a result of the holiday break.

Scotland and the North

Active conditions rule throughout the Scottish iron and steel industry. Consumers in the Scottish industrial districts are fully employed almost entirely upon war work, and as a result there is an insistent demand upon the steel works. All the finishing branches are operating at capacity, and there is a tendency for delivery dates to lengthen. Steps, however, are being taken to check this movement, and this has involved some readjustment of rolling programmes. Production in practically all branches is at a high level, and since there is no lack of raw materials, it should be possible to maintain outputs for a long time. The demand from the shipyards on the Clyde for plates shows no signs of declining, and as there is a big programme of construction in hand at the yards it is probable that the present position will rule for an indefinite period. In addition to the shipbuilding industry, tank makers, wagon builders, and heavy engineers are also pressing for deliveries of plates. The demand covers most thicknesses, but is especially insistent in the heavy building section of the trade. The locomotive and power plants in Scotland are fully engaged on war work, and their requirements of steel have reached a high level, but the works have maintained their deliveries, and no reports are current of manufacturers engaged on essential work having to go short of supplies. The structural steel position varies considerably. The demand for heavy joists and sections is comparatively poor, but lighter sections are required in increasing quantities, and there is a particularly urgent request for the sizes used in shipbuilding. Construction engineers generally are only moderately employed, and there seems little likelihood of any immediate change in the position ruling in this industry. The engineering shops on the Clyde are engaged on orders for the Government, and their requirements include large tonnages of steel bars. Big tonnages of the larger diameters are passing into consumption, and lately re-rollers have experienced a sharp request for small steel bars, as well as reinforced concrete rods. All the engineering works in Lancashire are busily employed. An important volume of business is passing in steel bars, whilst there is an urgent demand for plates. The call for alloy steels is on a considerable scale. All departments of the steel works on the North-West Coast are fully engaged. Heavy and light rods, semis, and brass bars and hoops are being produced in considerable quantities.

Copper, Tin, Lead, and Spelter

In spite of the huge consumption of copper which has ruled in this country almost from the outbreak of war, the demand tends to increase, as, in fact, it does in the case of most other non-ferrous metals. Arrangements which were made by the Government at the beginning of the war, however, have proved effective in maintaining supplies sufficient to cover all wartime requirements. Large quantities of copper are passing into consumption in the manufacture of shell cases, whilst other types of munitions also are taking up large tonnages. The shell cases are made of brass known as 70/30, and it is chiefly for the manufacture of this material that such large quantities are required by the brass makers. In the United States efforts are continually being made to expand production, and the authorities have announced their intention of developing a mine with the object of quadrupling its production. . . . The situation in the tin market is unaltered, and whilst restrictions upon the use of the metal have resulted in a considerable saving, efforts are still being made to cut down the consumption. At the same time steps are being taken to increase the production in the countries of origin remaining to the United Nations. It is suggested that the economies effected have enabled the stocks of tin in Great Britain and the United States to be preserved intact. The American War Production Board is considering an official collection of old tin cans in thirty-six metropolitan districts for de-tinning. . . . The lead position may be regarded with a moderate degree of satisfaction. It is understood that the Non-ferrous Metal Control, by drastic supervision of the distribution of the metal, has effected a considerable saving in its use. The concentration of the manufactured lead products industry is proceeding satisfactorily. Applications for licences are strictly scrutinised, and the metal is only released for essential purposes. . . . The spelter position remains tight, but there have been no complaints of consuming firms employed upon war work being held up for lack of the metal. In America steps which had been taken to economise in the use of spelter have resulted in the position becoming less stringent.

Notes and Memoranda

Rail and Road

SWITZERLAND DELIVERS ROLLING STOCK.—Under what is doubtless pressure the Swiss authorities have sent to Germany twenty-seven steam locomotives and several thousands of goods wagons in order to bring back imports to Switzerland.

RUBBER FROM THE WEST INDIES.—A colonial source of supplies of rubber hitherto not too well worked lies in Trinidad and Tobago, where are approximately 150,000 rubber trees which yielded in 1941 147,588 lb. It is hoped that more intensive tapping would yield between 250,000 lb. and 300,000 lb. annually.

THE SEVERN TUNNEL.—Fresh signalling provisions have been installed in the Severn tunnel. The original one block system has given place to intermediate signalling. Visibility in the tunnel was liable to be obscured by steam. This difficulty has been overcome by some minor changes in the general operating principles which have been employed elsewhere on the G.W.R. since it first made use of intermediate signalling in 1907.

AIRCRAFT ON THE HIGHWAYS.—What are known in the U.S.A. as "flight strips" are being constructed alongside certain new public roads. Reduced to its simplest terms, a flight strip is an area for the landing and take-off of aircraft, adjacent to the public highways, and maintained as a part of the highway right of way or roadside development area. In the United States legal basis for this innovation is found in the Defence Highway Act of 1941. These runways must be not less than 150ft. in width and should be not less than 3000ft. in length for the use of pursuit aircraft and not less than 4000ft. in length for the use of all other military aircraft.

Air and Water

SCHOOL FOR SHIPS' FIREMEN.—A school for the training of ships' firemen was opened in the London docks area on Monday, June 22nd, by Mr. Noel Baker, Parliamentary Secretary of the Ministry of War Transport. It will be recalled that a similar school was opened in Cardiff a few weeks ago.

LIGHT ALLOYS IN SHIP CONSTRUCTION.—A research scholarship of the value of £250 per annum and tenable for two years has been founded by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a Committee of the Institution of Naval Architects, and it is hoped to make the award in September, 1942. Full particulars of entry, which closes on July 31st, can be obtained from the Secretary, Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1.

THE SOUTHAMPTON TO COME.—The Southampton Town Council has before its members a report on replanning, prepared by its own planning and development office in consultation with an expert from outside. It provides, among other things, that after the war Southampton may become an important air transport centre. Moreover, the scheme embodies proposals in suspense for reclaiming a large area of land along the north bank of the estuary of the Test. Here is to be constructed a wharf, 7000ft. long, along with a dry dock capable of accommodating the largest passenger vessels in the world.

WATER SUPPLY TO BE UNDER ONE BOARD.—Some thousand municipal, public, and private waterwork systems in the Province of Quebec, Canada, supplying water to more than 2,000,000 persons, have been placed under the jurisdiction of the Quebec Public Service Board. Under the ordinance providing for the change, waterworks will not be allowed to operate without a permit from the Board; all private waterworks systems are compelled to submit annual reports, and to keep available plans of their plants and systems. Commenting on the Order, the Board said its control would improve sanitary conditions, offer better protection to the consumer, and exercise stricter control over the plants.

AN IMPROVED HANGAR DOOR.—An innovation in airport hangar construction has been introduced at an aerodrome in Texas, U.S.A., where there is a civil elementary flying school. The doors collapse vertically, to disappear into trenches below floor level. At each end of the hangars one of these novel doors is used to make possible a 20½ft. high by 100ft. wide opening. The doors are of steel construction, and each weighs 9 tons. They are so built that they may be collapsed in a vertical plane to fit into a 5½ft. deep, 20in. wide trench, which is provided with an exterior covering, 30in. wide, made up of longitudinal leaves of sheet metal. These leaves are stacked side by side when the door is lowered into the trench.

TIMBER SHELTERS.—The U.S.A. and Canada are saving steel by using timber for indoor shelters against air raids. Each shelter resembles a short section of a Nissen hut, and is constructed entirely of fitted wood without nails. The shelter has been tested to withstand 10 tons of *débris*. It has room for a standard double bed mattress with extra space at both ends, and is ventilated on both sides.

JOINT MARITIME COMMISSION.—The Joint Maritime Commission of the International Labour Office, consisting of representatives of shipowners and seamen, has recently discussed the equipment of vessels with life-saving appliances and the various essential points to be included in a standard of safety measures. A number of detailed suggestions were submitted by the Seamen's Group and discussed by the Commission. An exhibition of life-saving appliances which had been brought together specially by the Ministry of War Transport at the place of meeting was found of great interest by delegates. The exhibition included types of life-saving equipment with models and detailed plans from wireless transmitters to specimen types of rations to be carried in lifeboats.

Miscellanea

COPPER FROM A REVIVED SOURCE.—The U.S.A. State Director of the War Production Board has decided that copper must be mined again in Vermont and by a new corporation, the Vermont Copper Company. Copper has not been mined in Vermont for fifteen years.

INSULATED WIRE-STRIPPING DEVICE.—The insulated wire-stripping device described on page 524 of our issue of June 19th was, in accordance with information furnished to us by the makers, stated to be supplied with energy from a current transformer with a continuous rating of 250 kVA. We are now informed that the rating should have read 250 VA.

OIL IN SOUTH AFRICA?—The intention of the South African Department of Mines to bore for oil in the near future is announced. The possibility of gusher oil being struck is considered to exist. Meantime, the Academy of Sciences of the U.S.S.R. has organised an expedition to prospect for oil and develop already known deposits in the Volga and Urals oil basin.

THE LATE MR. W. D. DOWNIE.—We regret to learn of the death on June 22nd in his sixty-ninth year of Mr. William Duncan Downie, a director of Dawson and Downie, Ltd., engineers and pump makers, Clydebank. Mr. Downie was well known in engineering circles on Clydeside, having been in practice as a consulting engineer before joining Mr. Alexander Dawson, the present chairman and managing director of Dawson and Downie, Ltd., in founding the business at Elgin Works, Clydebank, over thirty-six years ago. Mr. Downie was at business until within three days of his sudden death.

NICKEL-CLAD STEEL.—Once more the use of nickel-clad steel for unfired pressure vessels has been approved by the A.S.M.E. Boiler Code Committee, and details of the Committee's recommendations have been published. Providing a vessel is to be used at pressures not exceeding 100 lb. per square inch and/or at temperatures not exceeding 120 deg. Cent., the thickness of the nickel, as well as that of the steel, may be included in the design calculations; but if either the working pressures or the temperatures exceed those indicated, it is specified that the thickness of the steel only should be taken into account in the strength calculations.

FACTORY VENTILATION IN THE BLACK-OUT.—Hurried measures taken on the outbreak of war to black-out factories often resulted in serious interference with the means of ventilation and affected the health and productive capacity of the workers. Much has since been done to remedy the defects, but the subject remains one of pressing importance, particularly in the summer months. A pamphlet, "Factory Ventilation in the Black-out" (Form 301), was issued in the early part of the war, and has now been reissued in a slightly revised form by the Factory Department of the Ministry of Labour and National Service. The pamphlet describes briefly the various measures which can be taken to improve ventilation without permitting the escape of interior artificial light, such as mechanical ventilation, provision of light-trap ventilators, and stimulation of air movement. A number of drawings are included, showing simple ideas for the construction of light traps at ventilator openings, such as windows and other wall and roof openings. Copies of the pamphlet may be purchased from H.M. Stationery Office, price 4d. post free.

SHORTER COURSES AT LEEDS UNIVERSITY.—Leeds University is to arrange its courses—or some of them—so as to release its students as early as may be for national work. The plan aims to compress into five terms courses for degrees and diplomas—in the Faculties of Arts, Science and Economics and Commerce—which normally cover three whole academic years.

THE LATE MR. W. A. BENTON.—We regret to have to record the sudden death of Mr. William Alfred Benton, at his home at Handsworth, Birmingham, on June 19th, 1942, at the age of seventy-one. For many years Mr. Benton was in charge of research at W. and T. Avery's Soho Foundry, Birmingham, and was a well-known figure in scientific circles. He was a Fellow of the Physical Society and a Past-President of the Birmingham Metallurgical Society. Amongst other activities, he enjoyed membership of the Society of Chemical Industry, the Newcomen Society, and the Wolverhampton and District Society. During the last few years he had been compiling a monumental work on the history of the balance, the greater part of which had been completed at the time of his death.

Personal and Business

DR. G. E. FOXWELL has been elected Chairman of the British Chemical Plant Manufacturers' Association.

MR. T. B. KEEP has been appointed Deputy Director-General of Production Services, Ministry of Supply.

THE INSTITUTE OF PETROLEUM has transferred its office from Birmingham to c/o Imperial College of Science and Technology, Prince Consort Road, South Kensington, London, S.W.7.

MR. ALEXANDER DUNBAR has been appointed Controller-General at the Ministry of Aircraft Production in succession to Sir Charles Craven, whose resignation, on medical advice, was recently announced.

THE WHITEHEAD TORPEDO COMPANY, Ltd., the Thames Ammunition Works, Ltd., and the Variable Speed Gear, Ltd., are to be merged in Vickers-Armstrongs, Ltd., in order to co-ordinate more closely their activities. All these companies are wholly owned subsidiaries of Vickers-Armstrongs, Ltd.

BRITISH INSULATED CABLES, Ltd., announces that Mr. T. H. Martin-Harvey has been appointed deputy chairman of the company, and Sir Eugene Ramsden and Mr. B. Welbourn have joined the board. The following appointments have been made:—Mr. D. W. Aldridge, executive manager (works); Mr. F. Waine, executive manager (commercial); and Mr. W. H. McFadzean, executive manager (financial).

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous o having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Institute of Fuel

Friday, July 17th.—Connaught Rooms, Great Queen Street, W.C.2. Luncheon meeting to Major Gwilym Lloyd George, M.P. 12.45 for 1.15 p.m.

Institution of Chemical Engineers

Tuesday, July 14th.—Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1. Joint meeting, "The Separation of Gases," Dr. M. Ruhemann. 5.30 p.m.

Institution of Electrical Engineers

Thursday, July 9th.—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. Informal discussion on "Wartime Maintenance of Electrical Installations and Equipment," opened by S. W. Field. 6.5 p.m.

Institution of Production Engineers

Monday, July 13th.—MANCHESTER SECTION: College of Technology, Manchester. Informal discussion on "Production Problems." 7 p.m.

Men of Maudslays

To-day, July 3rd.—Visit the Smethwick Foundries and Rolling Mills of Mr. Cyril C. Maudslay. Members from London leave Euston at 8.40 a.m. for Birmingham, proceeding thence by road to Smethwick. Luncheon at Blue Gates Hotel, Smethwick